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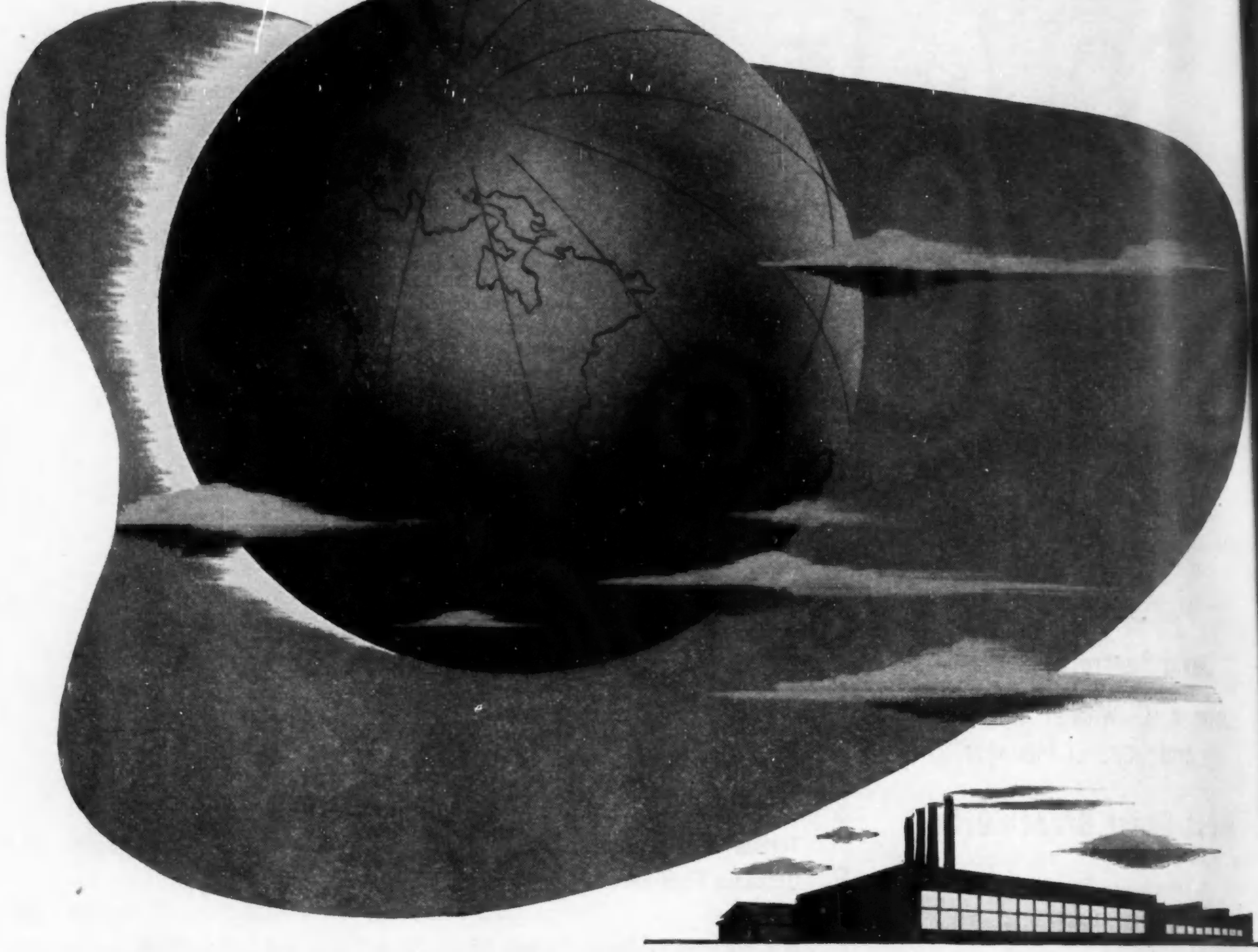

BENDIX BUILDS TODAY
for a Better World Tomorrow!

From dawn to dusk and through the night till dawn again, Bendix precisionists keep one goal in mind—Victory and a better world to come.

Through the colorful years of a quarter century, Bendix engineering and production leadership has been an integral part of the American automotive industry.

When America was attacked, blitzkrieg methods had already proved that swift-moving automotive vehicles were to play a dominant role in winning the war. It was only logical that our Government, facing these conditions, would include in assignments to Bendix the continued production of automotive units similar to its peace-time products—but on a scale never before dreamed possible.

Because of this wartime use of peace-time products, Bendix will be better able than ever to serve the automotive industry when decent folk turn again to peaceful ways.

In the meantime, an important part of the Bendix wartime task is to help automotive servicemen keep war-essential civilian transportation at peak efficiency.

THE INVISIBLE CREW
Precision Equipment by Bendix
AVIATION CORPORATION

BENDIX PRODUCTS DIVISION
South Bend, Indiana

"STROMBERG" CARBURETORS, "BENDIX B-K" VACUUM POWER BRAKES, "BENDIX" BRAKES, "BENDIX-WEISS" UNIVERSAL JOINTS, "BENDIX" CLEANER

TORTURE-TESTING WAR EQUIPMENT ★ ★

by MAJOR-GEN. G. M. BARNES
Chief, Technical Division, Ordnance Department

BEFORE a model of motorized or other Ordnance equipment is put into production by the Army it is given a series of torturous tests that would break the heart of its designing engineers. Brutal battles along the far-flung fighting fronts of the United Nations' bastions of democracy and civilization give the final proof. "Torture chambers" of Ordnance test laboratories and grueling proving grounds – which simulate actual combat conditions – seek out weak points day and night under carefully prepared test procedures calculated to develop weapons worthy of our hard-hitting soldiers.

The world's most extensive development and test laboratory is bounded by the United States and Canadian coast lines, with test facilities in the bleak far north and desolate hot deserts thrown in for good measure. Scores of test laboratories and proving grounds have been made available to the Ordnance Department by the automotive and other American industries to augment the specialized Ordnance laboratories of our six arsenals.

The Army Ordnance Department designs, develops, procures, stores, issues, and maintains weapons for our armies. The Technical Division is the design and development engineering department of the Army Ordnance Department. After we are satisfied that we have developed the best weapon extant, the using arms determine whether they want it or not. If they do, with or without modifications to fit it better into their tactical teams, the Ordnance Department is directed to have it built and delivered to our troops or allied forces. The Army Ground Forces, the Army Air Forces, Lend-Lease and allied purchasing commissions are our "customers." They must be satisfied. Requirements of the weapons themselves in a mechanized war on this scale make them tough customers.

Proof testing of automotive equipment, like all other Ordnance products, is carried out strictly in accordance with definite, clear-cut programs. Following exhaustive tests of mechanical performance, fire power, and ability to withstand enemy gun fire, a vehicle gets the complete treatment of cruelty. Out across open fields it goes, plunging down precipitous banks, across rocky gullies and fording streams, climbing steep grades, bulldozing its way through underbrush and over fallen tree trunks, and wallowing through marshy muck – all in the hands of a heavy-footed soldier hell-bent to reach his objective.

Our automotive test procedure, developed largely by SAE Member William F. Beasley, one of our veteran

civilian engineers, is of a progressive nature. The prescribed series of tests gradually increase in severity, culminating in tests to destruction. Each step is carefully observed and recorded on specified forms. Thus our Automotive Proof Reports serve as a measure of the useful life of the equipment under test and are a guide to future

Specialized Ordnance Development Branches

SERVING under the Chief of the Technical Division, Ordnance Department, are five specialized development branches manned by experienced engineering officers and civilian specialists. They are:

Ammunition Development Branch, Col. William A. Borden, who is also deputy chief of the Division;

Artillery Development Branch, Col. W. R. Gerhardt;

Tank & Motor Transport Development Liaison Branch, William F. Beasley, chief engineer;

Aircraft Armament Branch, Col. H. A. Quinn, chief.

A group of about 20 technical consultants meet with the various Branch chiefs and the chief of the Technical Division. These branches are served by the Industrial Design Section, which prepares drawings, models, and photographs of new and improved items.

Besides the Administration Branch, there is a Service Branch under Col. S. B. Ritchie, which coordinates and supervises various service functions for the development branches. This group prepares specifications, supervises engineering studies on the conservation of critical materials, investigates inventions submitted, maintains liaison with other technical agencies, and obtains and disseminates technical information from foreign countries.

engineering design. Although our tests often disclose tactical characteristics as well, the using arm conducts a series of tests of its own before deciding whether the equipment is wanted or not.

The first step of our standardized procedure calls for a complete mechanical inspection of the new vehicle. If engine block testing is called for, SAE specifications are used. Usually the manufacturer's data on engine performance suffice, but sometimes a complete check of the engines is directed by the Office of the Chief of Ordnance. Transmission, axles, and wheels and track are checked for power loss and other performance characteristics. Always special attention is given to lubrication and the relative ease of maintenance, because if the vehicle is accepted it must undergo unbelievably severe treatment in combat.

A series of measurements determines its center of gravity, load distribution, tire and track ground pressures, limits of range of vision, and areas of fire.

Then the vehicle is fully lubricated, with the points of lubrication, types of oils and greases, and amounts, recorded. It is then run at prescribed low speeds over given distances for breaking in before full-throttle operation. Starting characteristics, both with self-starters and crank, are recorded at various temperatures. Careful observations are noted of noise of operation, flame or flash from the exhaust at night, and the relative ease of concealing the vehicle from the enemy.

Its ability to cross obstacles is then analyzed. How well it can bridge a gap between two solid edges without its parts interfering is then studied and reported. Trench crossing and climbing over vertical barriers are required tests. Traversing barbed wire entanglements is usually called for. The vehicle's fording ability is studied to see how it behaves in water and marshes.

Turning ability is tested at various speeds on concrete, dirt roads, across open fields, over gravel or crushed stone, sand, and soft mud. The minimum turning circles, left and right, and the behavior of the track or tires in respect to loading and picking up stone and gravel, and the damage to roads, are all recorded on standard forms.

Maximum slopes which the vehicle can safely take, both longitudinally and laterally, are measured. Its maximum and minimum speeds in various gear ratios, and braking characteristics, are charted with tabular data recorded to support the curves.

Suspension flexibility, riding qualities, firing platform stability, and the ease of the crew in serving its guns are recorded by a series of measurements and gun-camera photographs. A chart is made of the exact travel of the tires or track when the vehicle's guns are fired through its entire range of firing angles.

Continuous operation tests are then made. At Aberdeen Proving Ground this consists of a 14-mile standard cross-country run. Full equipment or a simulated load and a full crew are used. Careful observation is made of the riding comfort and safety of the crew, both in hot weather and in rain and sleet. A running record of all salient factors is made with moving pictures which are studied by our design engineers on the vehicle as a guide for making improvements. Radio tests are made by the Signal Corps Laboratories at Fort Monmouth, N. J., and are incorporated in the final report on the vehicle.

The complete record of the tests, with all standard forms, graphs, data tables, still and moving pictures, together with copies of all correspondence authorizing and relative to the tests, is bound and filed. The report includes recommendations of the various test officers, and their suggestions for modifications and recommendations in respect to standardization of component parts and suggested maintenance procedures. Daily log sheets of the tests are included to augment the record of the torturous tests used to determine the mechanical performance and relative potency of the new vehicle.

This record is then studied by our all-important Ordnance Technical Committee after a specialized subcommittee has gone over it in detail. This Ordnance Technical Committee is composed of representatives of all the arms and services of the Army, with Navy and Allied liaison.

■ Additional Check Needed

For example, the Corps of Engineers must approve bridge-loading weights of vehicles destined to travel over roads and bridges they build. The Medical Corps must be satisfied as to the relative safety of the proposed vehicle, and the ease of removing dead soldiers stiffened by *rigor mortis*, and the wounded.

Each of the arms of the Army has its own technical boards which determine how well the new equipment will

fit into their respective combat needs. Here is where our "customers" take over, and put the vehicle through their own strenuous tests with their troops. Here, at camps from coast to coast, the experimental model competes with battle-tried equipment and other new models under a simulated baptism of fire in maneuvers until it is approved, modified, or rejected. Running accounts of its performance in the desert, marsh lands, in the far north – all as a part of our Army's combat teams – are reported in detail to the Ordnance Department.

Laboratory facilities of our six arsenals are specialized. Each of them makes a contribution to the development of a new combat vehicle, for example. Our arsenals stem from the establishment of the Springfield Arsenal, approved by an Act of Congress on Feb. 20, 1777. Springfield was at first financed by the Council of Massachusetts Bay when Gen. Washington instructed Col. Henry Knox to go ahead even before formal legislation had been adopted by the Continental Congress. As the head of our small arms development projects, Springfield Arsenal is in charge of automatic, rifle, and carbine design and manufacture for all vehicles from the jeep to the heaviest tank.

Specializes In Armor Plate

Armor plate is the specialty of our Watertown (Mass.) Arsenal. Thus this establishment is involved in all combat vehicle development. It is significant that the legislation providing for the Watertown Arsenal required that its equipment be made available to industry. Hydraulic strength-testing machinery developments in this country stemmed from the equipment designed and built by A. H. Emery in 1879. This landmark of Army-industry cooperation resulted in a series of annual reports entitled "Tests of Materials" and has guided an untold number of metallurgical developments since 1882, during this period of our nation's unprecedented development.

Research projects here and at other arsenals have helped to advance metal working. Reports covering projects on the plasticity of metals; improvements in foundry practices; methods of measuring liquid-steel baths; the nature of gun erosion; spectrum analysis of steels; development of instruments and techniques for examining metals – to name a few that have been useful to automotive engineers – have played their part in the nation's technical growth.

Since the early days when civilian engineers worked side by side with Army Ordnance officers in the original buildings of our first arsenals, the Department's use of civilian advisers has expanded on all technical fronts. This is of vast importance to our ultimate victory over the Axis nations. Individual engineers, engineering staffs of manufacturing companies and consulting engineering firms, and engineering schools of universities and colleges from coast to coast have been of incalculable service to our Ordnance engineers. We now have a network of engineering and scientific skills upon which we are continually calling to help us with tough problems in improving our weapons and developing new ones.

It would take many volumes to report on all of these cooperative engineering projects, many of which must remain secret until our ultimate victory. But those completed and many others now under way add up to extremely bad news for the Axis. Back in 1918 the Society of Automotive Engineers made available to us a group of outstanding engineers through the SAE-Ordnance Advisory Committee, headed then and now by Col. Henry W. Alden, a past-president of the Society. The newer SAE War Engineering Board is performing a valiant engineering task for us, and has submitted to us scores of valuable engineering reports and studies on design improvements and the conservation of strategic materials. Many of their recommendations are in production, and some are actually in the hands of our troops on foreign battlefronts.

Each of the thousands of prime- and sub-contractors working on Ordnance products has made some contributions in design of weapons or improved manufacturing and assembly methods. Major-Gen. Levin H. Campbell, Jr., Chief of Ordnance, and all of us are deeply grateful for the achievements of ingenious Americans who are helping to give our soldiers the best weapons on earth.

For example, gage laboratories were established in nine leading engineering schools to augment the gage laboratories of our 13 Ordnance Districts and our arsenals. This was done without cost to us except for equipment. The gage, perhaps the most apt symbol of mass production, has always been important in Ordnance thinking and operation.

The work of the Ordnance Technical Division consists of:

Planning and conducting research and development programs for new and improved Ordnance materiel and materials;

Supervising research and development programs in our arsenal laboratories;

Testing Ordnance products at Aberdeen Proving

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Fighting Arms Test Ordnance Equipment

EACH of the using arms of the Army maintains its own Service Board of experts to give final approval of Ordnance equipment destined for combat. They have their respective headquarters at these establishments:

Desert Warfare Board, Indio, Calif.;

Coast Artillery Board, Fort Monroe, Va.;

Anti-aircraft Board, Camp Davis, S. C.;

Ordnance Board, Aberdeen Proving Ground, Md., which maintains the Winter Warfare Board at Ft. Lewis, Wash.;

Field Artillery Board, Fort Bragg, N. C.;

Infantry Board, Fort Benning, Ga.;

Armored Force Board, Fort Knox, Ky.;

Air Forces Board, Eglin Field, Fla., with testing facilities at Wright Field, Dayton, Ohio, and other AAF fields;

Tank Destroyer Board, Camp Hood, Tex.;

Cavalry Board, Ft. Riley, Kan.

Special testing facilities, supplementing those at the Aberdeen Proving Ground, include the Milford (General Motors), Packard, and other automotive and non-automotive manufacturing companies. Automotive vehicles and other Ordnance equipment is given high-temperature tests at Camp Seeley, Calif.; low temperature tests at the Ordnance Winter Detachment, Camp Shilo, Manitoba, and submarine harbor mine work is done at Fort Monroe, Va.

Leading industrialists and educators get a first-hand description of salient characteristics of a light tank from BRIG.-GEN. JULIAN S. HATCHER. L. to R.: A. R. Stevenson, General Electric Co.; SAE Member K. T. Keller, president, Chrysler Corp.; Dean H. P. Hammond, Penn State College; Dean Ivan C. Crawford, University of Michigan; President R. L. Doherty, Carnegie Institute of Technology; President A. C. Willard, University of Illinois; President Karl T. Compton, M.I.T.; General Hatcher, and John E. Johnson, chief, War Products Training, General Motors Corp.

ORDNANCE FIELD SERVICE—

Connecting Link Between Producer and Soldier

by BRIG.-GEN. JULIAN S. HATCHER

Chief, Field Service Division, Office Chief of Ordnance

THE troops in all of our 70-odd far-flung theaters of operations look to the Chief of Ordnance to place in their hands the necessary bombs, ammunition, guns, and motor transport. Ordnance must be there when it is needed, where it is needed, and in the quantities needed. A soldier may fight for days without food, but a few minutes without ammunition may cost him his life and may cost the nation a campaign. Our soldiers in the field all over the world look to Field Service to have skilled Ordnance soldiers available to service their vehicles, their guns, their range finders, directors, and all of the complicated paraphernalia of total mechanical warfare. Field Service is that part of Ordnance that handles this storage, distribution, and maintenance job.

Ordnance includes all the bombs, ammunition, guns, tanks, and vehicles in the Army – everything that shoots, that is shot, or that rolls. Ordnance is coming off the production lines at the rate of over a billion dollars a month, and all of it must be received and handled by Field Service.

The ammunition problem in itself is staggering, for the quantities are astronomical, and ammunition handling and storage are specialties requiring the most profound technical knowledge and the most meticulous care to avoid disastrous accidents. Let us take a look at one of the 52 large Ordnance depots operated by Ordnance Field Service. This depot handles ammunition as well as general supplies, so it must be located far from any large concentration of human habitation, but at the same time convenient to excellent rail facilities.

As we enter the main gate, we are stopped by the guards, who examine our credentials with the greatest of care and then notify the commanding officer of our presence. Let us ride around the establishment with him. First, we pass a large group of warehouses, containing perhaps 3,000,000 sq ft of storage space. This is the combat material storage

[This paper was presented at the SAE National Transportation and Maintenance Meeting, New York, May 5, 1943.]

area, where the guns and tanks and cars and all of their spare parts are stored and issued. Including major items and principal assemblies, there are 288,000 separate and complete articles and 400,000 different component parts handled by Field Service.

In another part of the post is a group of excellent shops where maintenance and reclamation operations are carried on. It is to these shops that damaged articles from the field are sent for major overhaul or rebuilding. A maximum item of mortality common to all types of vehicles is deterioration of the engine. To meet this situation, Field Service has set up an extensive program whereby fifth echelon or base automotive shops have been placed in key locations to handle the gigantic project of complete engine overhaul. The pattern followed was taken from industry's development of the assembly line, and that is the basis for operations in these engine-rebuild plants.

Another important class of work done in these maintenance shops is the reclamation of unserviceable parts. In time of peace, with materials plentiful, a philosophy has grown up in America of discarding even slightly worn parts and replacing them with entirely new ones, but in times like this, when material shortages impose a valuation on every article far in excess of its mere dollar value, it becomes necessary to examine every possibility for reclaiming the old parts rather than building entirely new ones. This is done by processes with which you are fully familiar: for example, the chrome plating of slightly worn parts – piston pins, cylinder walls, and, in some instances, pistons – which are thus refinished to a standard size. This chrome plating has been particularly important in the reclamation of radial engine crankshafts.

Obsolete engines are being converted to current models by installing front motor supports and bell housings, and obsolete transmissions are converted to current use by replacement of front bearing retainers and main shaft at a cost of 30 min and $3 or $4 worth of parts, with a resultant replacement value of $85. Forty-five cents worth of material and 15 min of time turned two obsolete parts into a like-new starter worth $28.75. Worn and broken parts are converted; thus a Chevrolet universal joint cross-joint, worn beyond reclamation, is ground down to become a certain Dodge part, as good as new even under the Brinell test. Three GMC oil filler pipes, made obsolete by a crankcase ventilation modification, are cut and welded with scrap baling wire to make two Dodge breather pipes.

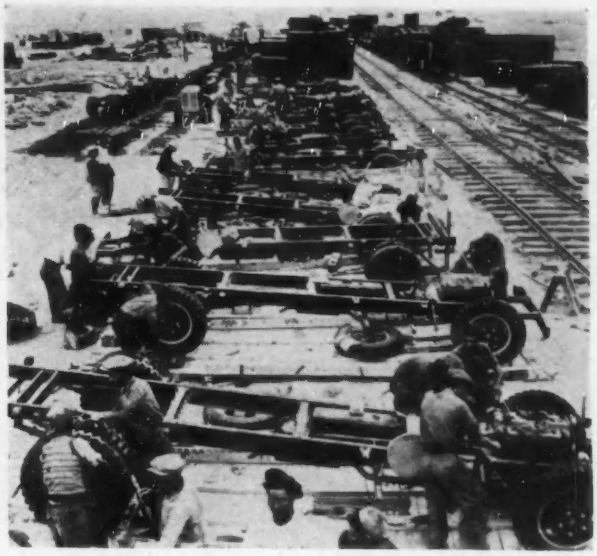
Sleeving of discarded seamless steel tubing is being used to put back into service transfer case yokes, universal joint crosses, pinion shafts, and fan pulleys.

Clutch pressure plates have been ground as much as 0.05 in. with such success that the manufacturer now agrees this is practicable.

This reclamation business is really just getting under way, but even so, at one depot alone more than $250,000 was saved during a period of 10 months through the reclamation of critical parts assemblies and instruments.

So much for the storage and maintenance sections of our typical Ordnance Depot. Now let us proceed toward a second gate, where the guard stops us and takes away all matches and cigarette lighters. This is the magazine area. Storage of ammunition is in underground magazines called "igloos." Hundreds of little humps in the ground cover the hills as far as the eye can see.

We drive for some time and seem to be getting further and further away with no end in sight, and as it all looks



Courtesy General Motors Corp.

Army Field Service in action somewhere in Iran, where Army vehicles are being assembled along a railroad siding near the Persian Gulf

Official photo, U. S. Army

Ordnance troops at Flora, Miss., are shown how a good tank trap works. Here maintenance men get practice on repairing serious damage to tanks and other equipment

Official photo, U. S. Army

Maintenance crew inspects overturned half-track prior to righting it with aid of block and tackle. Repairs will be made in the dark

the same we ask how much traveling we will have to do to cover all the roads in the magazine area. The answer is 130 miles, so we decide we have seen enough and then turn back toward the entrance. In this typical Ordnance

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War Engineering Opens Postwar Vistas When Diesel-F&L Men Meet

INTENSIVE war emergency research and development work on diesel engines and their fuels and lubricants will pay post-war users big dividends, speakers at the hugely successful SAE Diesel Engine and Fuels & Lubricants joint meeting June 2 and 3 at the Carter Hotel, Cleveland, declared.

The 10 papers prepared by 13 outstanding Navy, Army, and civilian engineers were attended by capacity audiences and were followed by enthusiastic discussions.

Keynote of two-day meeting was sounded by Capt. Lisle F. Small, Bureau of Ships, U. S. Navy, who told his audience at the dinner that the diesel prime mover had "won the Navy by a landslide" since the present diesel engine development program was begun in 1932 through the untiring efforts of Vice-Admiral S. M. Robinson, now production chief of the Navy.

Eleven short years ago the Navy had approximately 180,000 hp of diesels in service. Today the total is nearly 13,000,000 hp, with the figure steadily increasing, Capt. Small said.

As far as the Navy is concerned, the old battle between advocates of the two-cycle type of diesels against proponents of the four-cycle is ended. Both have what it takes to win wars, and the Navy is using as many of each as it can get.

Indirect final drives are forging ahead in Navy use either through reduction gears, electric, or a combination of electric-mechanical transmissions in order to save as much space in Navy ships as possible. As many as four prime movers are driving one shaft today. These composite arrangements permit smaller units which can be more readily made in more factories, and are more economical in operation in tactical use.

Welding developments came in for high praise by the Captain. Experts have developed techniques for building up large engine sections. Space and weight are saved, and the engine room crews are better protected in case of direct hits in battles, he pointed out.

A most serious problem, and one about which the speaker was frank to state too little was being done, is the matter of torsional vibration of crankshafts. Some manufacturers have licked the problem quite satisfactorily – others have not. The Captain believed the solution should be reached by joint and concerted action of the builders and engineering societies, so serious had it become in some respects. He particularly recommended it to the Society of Automotive Engineers as a problem worth its serious attention.

Today's bottlenecks in diesel manufacture and operation are:

Not enough crankshaft forging and machining capacities;

Not enough bearing manufacturing capacity, and

Need for spare parts and more spare parts.

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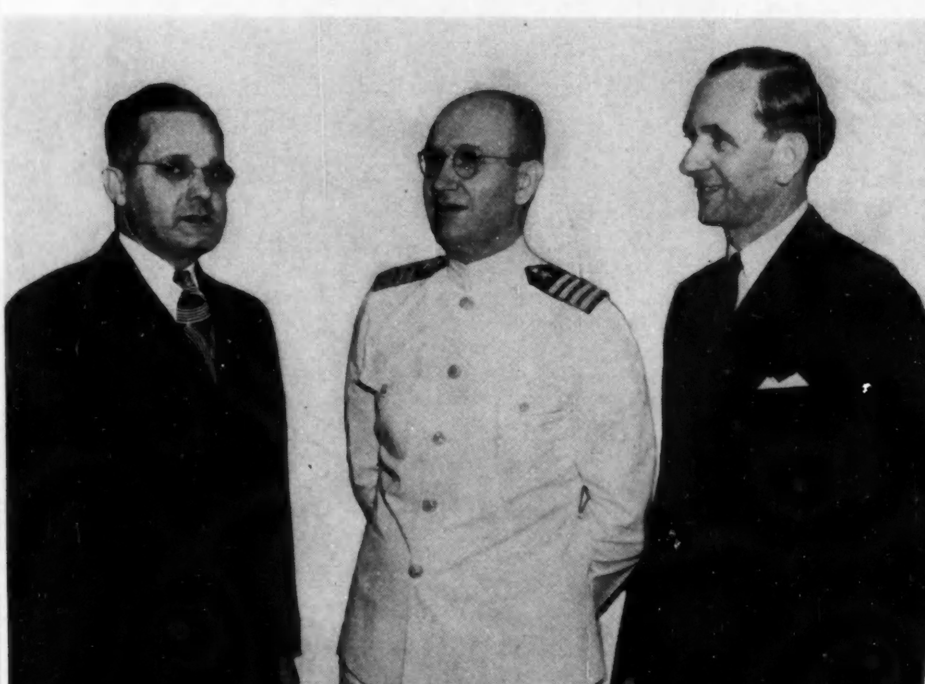
SAE President Mac Short, Capt. Lisle F. Small, USN, and John E. Hacker, pictured just before the capacity dinner June 2 of the Diesel Engine and Fuels & Lubricants Meeting in Cleveland. The captain, a Bureau of Ships officer, and Mr. Short, struck the keynote of the meeting – future engineering opportunities and SAE-Government cooperation to help win the war. Mr. Hacker was chairman of the general committee and toastmaster



Detroit War M...

Battle Experienc... Gui... In Designing Bett... Vel...

AMERICAN tanks, trucks and other fighting and carrier vehicles were dissected by military technicians for civilian engineers and by civilian engineers for military technicians at the SAE War Materiel Meeting at the Book-Cadillac Hotel in Detroit, June 9 and 10.

Stressed by Army officers throughout the sessions was the dramatic – and often tragic – importance of designing maximum accessibility* and general maintenance facility into all military units . . . and the ideal tank engine definitely was envisioned as aircooled.**

Civilian engineers brought out possibilities for improvements in a variety of constructions. Better production methods were described. Research experiences were detailed. Predictions about the future were made – including C. F. Kettering's: "Just to start an argument, I'll bet even money that we will have a steel airplane as soon as we have an aluminum automobile."***

Result: Better understanding of mutual requirements in technical attack of practical war problems all along the line.

Jointly sponsored by the Truck & Bus Activity, the Passenger Car Activity, the Production Activity and the Detroit Section, this war engineering conference – which brought together more than 700 engineers for the six-session, nine-paper program – was conducted under the auspices of a special committee with E. H. Smith as chairman. Other members were: E. W. Allen, E. W. Austin, Roy E. Cole, A. G. Herreshoff, Arnold Lenz, and E M. Schultheis.

In addition to emphasizing repair problems and tank engines, Army officers analyzed existing problems of design in suspension of track-laying vehicles. Engineers of the industry told of experience in shot blasting metals to in-

* See "Lessons Learned from World War II about Designing for Accessibility" by Col. E. S. Van Deusen beginning on p. 36 of this issue.

** See "Various Types of Tank Engines Compared" by Lt.-Col. R. J. Icks, beginning on p. 39 of this issue.

*** Extensive excerpts from "Looking at the Future Through the Eyes of Research" by C. F. Kettering begin on p. 33 of this issue.

Materiel Meeting

Guide Engineers Vehicles, Weapons

crease fatigue resistance; of recent progress in precision inspection methods; of possibilities for substitution of steel for aluminum of brake cylinder pistons; and of current knowledge and studies of SAE technicians about dust problems in military vehicle operation.

Windup of the meeting was the dinner on Thursday evening at which Rear-Admiral Ralph E. Davison, assistant chief, Bureau of Aeronautics, USN, complimented the automotive industry for its performance in naval aircraft production, but stated flatly that "as time goes on we expect more and more to come from the automotive-aircraft industry in the form of improved processes and materials."

Following his address, Admiral Davison showed a dramatic motion picture assembled from films taken by Naval photographers in action aboard Navy airplane carriers.

The dinner program was arranged under the auspices of the SAE Detroit Section . . . and Detroit Section Chairman A. G. Herreshoff opened the after-dinner program by welcoming members and guests to the nation's automotive armament center.

SAE Past-President W. B. Stout, presiding as toastmaster, introduced a totally new technique in his introduction of speakers' table guests, transforming what often is an innocuous hiatus in the program into a stirring reason for attending any future dinners at which he might be going to do it again . . . Speaking briefly in a serious vein, however, before introducing the speakers of the evening, Mr. Stout complimented SAE members as having done more to remake the world and to prepare our country for meeting effectively the challenge of technical war than any other single group in the country. The facts and verities developed from research, he predicted, will displace opinions as a basis for rebuilding after the war when two major revolutions – one in transportation and one in education – are certain to take place.

SAE President Mac Short made an inspiring report of SAE war-effort participation, based on his personal contacts and investigations in traveling to SAE Sections, committee sessions and general meetings throughout the country during the last six months. (Mr. Short's full story of these dramatic achievements will appear in the August *SAE Journal*.)

Passenger Car Vice-President Roy E. Cole; Truck & Bus Vice-President E. W. Allen; and Production Vice-President Arnold Lenz

Dinner Speakers and Toastmaster

SAE President Mac Short; Rear-Admiral Ralph E. Davison, USN, assistant chief, Bureau of Aeronautics, U. S. Navy; and Toastmaster William B. Stout

Flexibility of Air Output Necessity, Davison Says

A new large-scale method of manufacturing aircraft – geared to the demand of war – is emerging from combination of the automobile and aviation industries and from the willingness of those two industries to exchange experience and "know-how" freely, Admiral Davison told the members and guests assembled at the dinner on Thursday evening to hear his talk on "The Automotive Industry in Naval Aircraft Production."

"We probably never will see during this war mass production of aircraft as the automobile industry knows it," Admiral Davison emphasized, complimenting the car and truck engineers on their successful mental changeover to working procedures by which airplane design can be kept dynamic and constantly improving.

Admiral Davison assured the engineers that the Navy makes no change in design without a full review of the effects on production and a careful weighing of the results of the change on the performance of the equipment. "The price of supremacy in the air," he asserted, "is constant study of combat performance, with constant improvement as the result. Unnecessary changes," he assured, "we make every effort to avoid. Essential changes we intend to make – and we are depending on you to make them for us promptly, and with minimum effect on production schedules."

The necessity continually to study and to shift materials to avoid critical ones, was another major point stressed by Admiral Davison. "To secure the utmost from our resources," he urged, "will require all the ingenuity and skill at the command of Navy contractors."

Complimenting the automotive industry on an excellent job of planning, Admiral Davison went on to urge further extension of the subcontracting system, for the organization of which he credited the automotive industry; and bespoke maximum attention to industrial safety because "we cannot afford to lose any of our production soldiers."

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Cleveland Meeting Managers

Charles H. Miller, chairman of the Cleveland Section SAE, host to the Diesel Engine and Fuels & Lubricants Meeting, left, with Harry F. Gray, incoming Section chairman; R. S. Huxtable, in charge of the meeting arrangements; and Robert Cass, chairman of the Display and Social Half-Hour Committee

Diesel-F & L Men Meet

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Cast shafts are "saving the day" in many instances, and better maintenance training is being undertaken to substitute for new repair parts and sub-assemblies, of which there never seem to be enough on hand in parts centers and depots. Along with improved maintenance training of the Navy's personnel, salvage depots are being set up to reclaim parts for which an extended life seems possible. The situation is still not good, but the speaker looks most hopefully on the training programs now being conducted at manufacturers' service schools, technical schools, training stations, and so on.

Informative and well-prepared and illustrated service manuals are invaluable, declared Capt. Small, and no manufacturer should slight their content and presentation of subject matter; it is hard to realize just how helpful they can be.

A word for the future was cast out for attentive ears by the speaker – "Watch the gas turbine – it seems to have a future." Even today, the Navy is investigating this not too new, but relatively unapplied, source of power.

In closing, Capt. Small expressed his own deep appreciation, both personal and for the Bureau he represents, for the fine and long-standing spirit of cooperation manifested by the automotive industry and the Society.

SAE President Mac Short reviewed the Society's role in the war effort. Taking as his theme, "The SAE on the National Battle Fronts," Mr. Short revealed how steps were taken as long ago as 1938 to prepare for what has proven to be the "War On Wheels." In that year, Col. Louis Johnson, then Assistant Secretary of War, congratulated the SAE on its policy of inaugurating a program for wartime (national defense) production. Office of War Mobilization Chairman James Byrnes publicly commended the automotive industry for an outstanding job, well done, only a few days ago.

The SAE has been in the fore in supplying key men to man important Governmental agencies, and in forming committees to investigate and determine possible courses of procedure for industry and Government alike. Some programs are voluntary, others Government-sponsored, but results are being obtained rapidly on a wide front of engineering projects. There are over 250 committees at work, and more than 2000 men are at work in them. They meet on the average of every other day. The distribution of more than 2,000,000 SAE aeronautical specifications testifies to the value of only a part of the SAE war work, he pointed out.

"With a 10% technical edge over our enemies, we can wage a winning war. We have this edge, and can maintain it," Mr. Short said. "And after the war, the SAE will be in there pitching, too!"

The Cleveland Section was the official host for both technical and dinner programs, the direction being provided by Charles H. Miller, chairman, and John E. Hacker, chairman of the meeting's General Committee.

Program Planners

George Lange, meetings chairman, Diesel Engine Activity, left, with William M. Holaday, SAE vice-president for Fuels & Lubricants Engineering; Grover C. Wilson, SAE vice-president for Diesel Engine Engineering; and Gilbert K. Brower, meetings chairman, Fuels & Lubricants Activity. Messrs. Lange and Brower also served as session chairmen

Principles of Acoustics Used to Quiet Diesels

THE manner in which an exhaust pipe acts as a noise generator, and a method of utilizing waste energy in the exhaust gas to improve scavenging of low-speed two-stroke engines were discussed by Ralph L. Leadbetter, Acoustic Division, Burgess Battery Co.

Sound can be considered as a pressure wave set up in the air by the rapid acceleration of a body or by the sudden expansion of gas into the atmosphere.

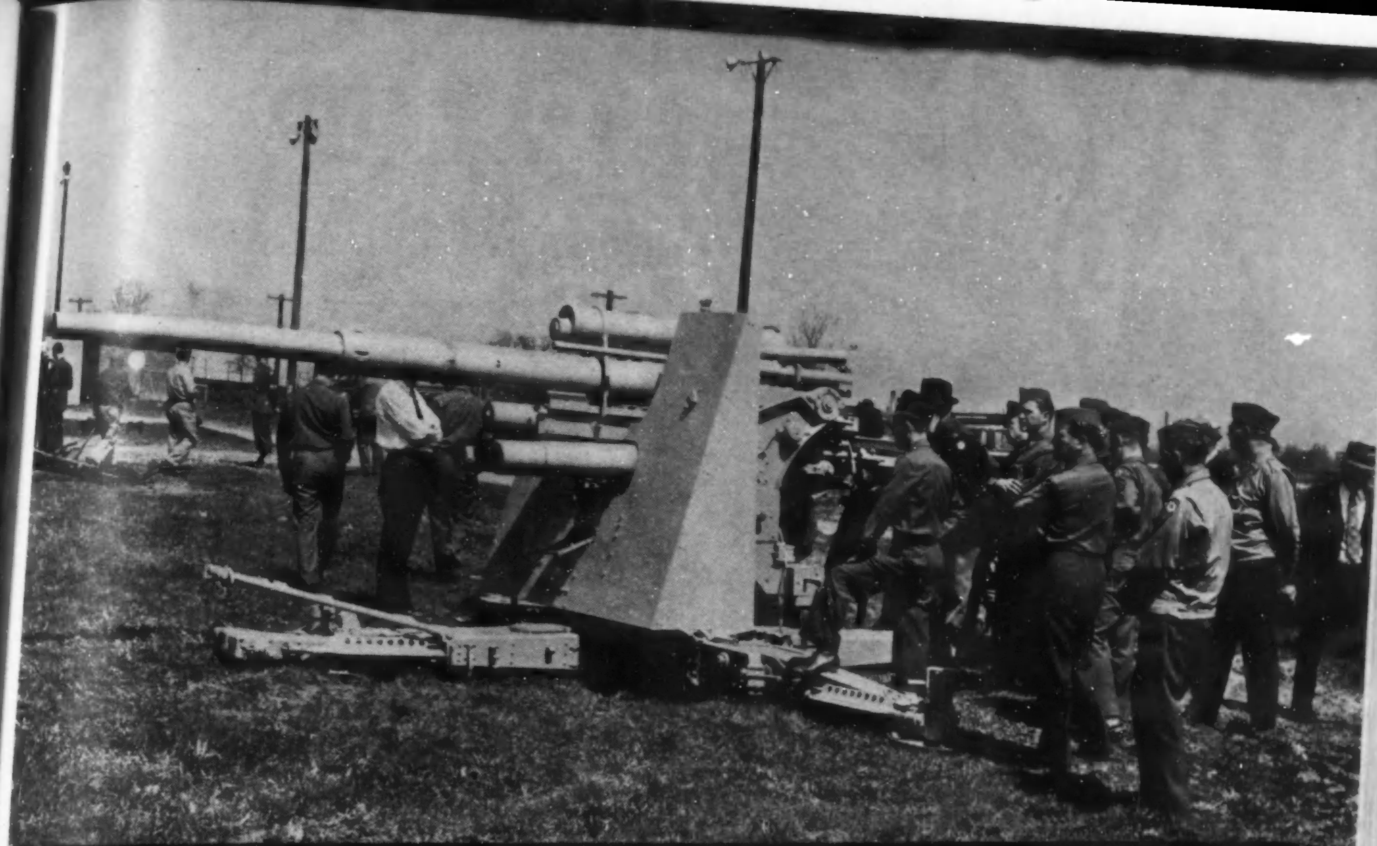
In an exhaust pipe, the gas released when the exhaust outlet is opened is confined by the pipe walls, so that it is free to expand in only one direction, that is, toward the open end of the pipe, and air or gas present in the pipe is forced out ahead of this expanding column of gas. Studies of this exhaust gas column lead to the following conclusions:

1. The nature of the discharge of the gas from the engine into the exhaust pipe keeps the column of gas in a state of longitudinal oscillatory motion.
2. Under these conditions, acceleration causes noise at the open end of the tail pipe.
3. The actual particle displacement of the gas molecules in the pipe is relatively enormous, amounting to oscillating flow at acoustic velocities.

Before the expansive force of the gas in the pipe is spent, displacement along the axis is much greater than when the gas is free to expand in all directions. The inertia of this high-velocity gas, as it attempts to pass through the silencer at speeds above the minimum required to permit free scavenging of the engine, can be made to carry the gas across a gap and into a snubbing chamber, a shunt path being provided for unrestricted outward flow of the gas discharged into the snubbing chamber by the previous pulse. The braking effort applied to this gas flow varies as the velocity squared. At acoustic velocities, the braking effect is great, while at velocities due to normal flow, it is relatively insignificant, and free scavenging is permitted.

The exhaust pipe, said Mr. Leadbetter, should be considered an integral part of

turn to page 58 following Transactions



Captured ENEMY EQUIPMENT

Shipped to Aberdeen Proving Grounds from overseas battlefronts, these weapons of the Axis were photographed especially for the SAE Journal while being tested and studied by Ordnance officers

Above

Germany touched off a hot one when they used this 88 mm anti-aircraft gun as an anti-tank weapon in an earlier stage of the North African campaign, after successful use against the Maginot Line in France. The U. S. 90 mm dual purpose gun fires a heavier projectile at a greater range and is considerably easier to emplace for action

■

A Japanese automatic rifle on a bipod stand, and a light machine gun on a tripod, are close copies of European types

■

Less effective than the U. S. 37 mm, this German anti-tank gun has deferred to their 47 mm and 50 mm pieces. This fires at the rate of 8 or 10 rounds per min

The German 88 mm dual-purpose gun is built of heavy castings and riveted sections, is relatively hard to handle, and provides little cover for gunners

German 105 mm howitzer has a muzzle velocity of 1550 fps, maximum range of 11,000 yd with a 35-lb projectile. Field of fire is restricted by its carriage – unlike the U. S. 105 mm gun

German 81 mm mortar is similar in design to the U. S. weapon of the same caliber. Its 2000-ft range is less than our gun

German half-track carrier and prime mover weighs 21,000 lb. is 26 x 8 ft. Engine is a 6-cyl, 160-hp unit. Carries 16 men

Despite its husky appearance, this German 10 cm gun, mounted on a four-wheeled bogie when in transit, belies its looks according to Ordnance officers who have tested its performance at Aberdeen Proving Ground

German volksvagen, right, shown with the fast, husky American jeep. Inset shows rear engine compartment, with small aircooled engine of about 11 hp

German version of the U. S. "Tommy-gun" is being inspected at Aberdeen Proving Ground, Md., by (l. to r.) Major-Gen. T. J. Hayes, chief, Industrial Service, Army Ordnance Department; Major-Gen. Milton A. Record, commanding Third Service Command; Major-Gen. Levin H. Campbell, Jr., chief of U. S. Army Ordnance, who is holding the gun; Major-Gen. Charles T. Harris, Jr., Commanding General, Aberdeen Proving Ground; Brig.-Gen. Hugh C. Minton, chief, Resources and Procurement Division, Headquarters, Services of Supply. On the table in front of the Generals are a number of other German "Tommy-guns," including a parachutist's machine-pistol with folding shoulder stock. The German "Tommy-guns" are known as "Schmeisser machine pistol 40," caliber 9 mm. U. S. Ordnance examination and firing tests show the German gun has a shorter range and less striking power than the American sub-machine guns

Comments by "KET"

Excerpts from talk entitled "Looking at the Future Through the Eyes of Research" given by Charles F. Kettering at the SAE War Materiel Meeting in Detroit on June 10, 1943.

Progress—at a Price

THIS war is throwing engineers out of their normal grooves – and they will not go back into the same ones they got out of. That is one of the net gains we are going to get – paying an awful price for it, however.

Orchids to A&N

SOME day you are going to get out a vote of thanks to the Army and Navy engineers for the job they did during peacetime – when they didn't have any money because everybody knew there wasn't going to be another war. . . . They made samples – knowing just as well as you and I that they weren't necessarily the best samples in the world – but they were samples. They had been run. Our big progress when war came was due to the fact that we had those working samples to start from.

Post-War Planning

SOMEBODY has said there are more than 300 post-war planning groups in the country. Well, that isn't enough. There ought to be more than 130,000,000 post-war planning groups. Every man ought to be his own.

We have a simple test to distinguish between post-war planning and post-war wishing. . . . If the plan presupposes that human nature is going to be different after the war, it is pure wishing – and can be thrown out.

On this basis, very little post-war planning is being done. When you take the wishing out of post-war planning, it gets down pretty much to being plain drudgery like anything else. . . . The fundamentals of human nature are going to remain after the war exactly the same as now.

Say the human race has been on earth for a million years (some say it's two million). Well, we have only been able to mark an "X" on the wall of a cave for about 10,000 years . . . and we got up to that point from the start without benefit of science, medicine or anything like them.

. . . And a fundamental part of all biology is continuity. If you plant a pea in your Victory garden you expect it to come up peas. . . . You don't expect it to say: "Because the war is on, I'll be a chrysanthemum now." . . . If you buy a dog, you expect him to act like a dog. . . . A fellow laid on my desk the other day a study showing that since

640 B.C. (I think) the world has been at war about one-third of the time. None of these wars except this last one has bent human nature any. This last one has changed our thinking a little bit, but it hasn't changed human nature.

Inventors

AS you know, I am chairman of the National Inventors Council. Out of our experiences has come a notion that we can educate people to be inventors. The way to do it is to teach people how to fail intelligently. That is all you have to do to be an inventor.

We have made two or three surveys that show that the more education a man has, the less likely he is to invent. It should be exactly the other way, but we think we know why it isn't. The average kid, from the time he is six years old until he is graduated from college, gets examined three or four times a year – and if he flunks once, he is disgraced throughout his community. So it has been a disgrace to fail ever since the kid became conscious. . . . But the only time you ever succeed when you are an inventor is the last time you try. Inventing is 99.9% failure. . . . So we have to teach people how to fail intelligently.

Post-War Automobiles

RECENTLY I mentioned the fact that I thought the public would get, right after the war, the same automobiles they had just before the war started. *Printer's Ink* wrote a letter to a friend of mine saying: "Please advise Mr. Kettering that the survey we have made indicates that the American public will not accept the automobiles they had just before the war."

That is perfectly all right, but if they don't accept such automobiles they aren't going to get any, because we haven't anybody in our organization working on automobiles at all. You couldn't get any material if you tried to work on them, and nobody wants to use material for that purpose. I think our men would quit if we asked them to.

. . . Nevertheless, we know that, as we pick up after this war, everything is going to change. The curve of progress will accelerate as it goes along – and we will drive ahead as long as competitive industry is allowed to function. The public is going to get all that is available in everything.

The Kilgore Bill

IF management and engineering do not have mutual understanding about the essential of long-range research, then the long-range research is going to be done by Government agencies. That is what the Kilgore Bill is.

We have a lot of people in Washington who say if the world is going to progress it has got to be done by Government research and Government development, because industry won't do it – despite the fact that industry has done a pretty good job on the production of things we have today.

Now what makes these people say you need centralized research and development in Government? What is wrong with what has been done?

Well, they say that XYZ company, which is manufacturing a certain kind of engine, won't spend money to work on an engine on either side of it, so to speak. The company crystallizes on a particular thing and won't investigate on either side of this type. They insist that this must be done, so that the manufacturer will know whether he is in the middle of the road or not – whether there is something better on one side or the other.

Actually, competitive business does exactly what these people think we haven't done. If you have a competitor, he certainly takes the blinders off you and forces you to look back and forth. Competitive business has the necessary flexibility to a high degree, but we haven't been expressive enough to say what it is.

Steel vs Aluminum

I WAS talking to a fellow the other day from one of the big steel companies. He said he didn't know what was going to happen to the steel business, what with the increased facilities for producing aluminum and magnesium and plastics and all that sort of thing.

"Why does that worry you?" I asked him.

"There is a lot of research going on," he said, "in all these other materials."

"Why isn't there a lot of research going on in the steel business?" I asked.

He said: "There isn't much more you can do with steel."

Well, I can't understand that. We want stainless steel, and we want all sorts of new kinds of steels. . . . An aluminum fellow from Canada the other day asked me what we are doing in development of aluminum automobiles. I said:

"We aren't doing anything . . . and just to start an argument, I will bet you even money that we will have a steel airplane as soon as we will have an aluminum automobile."

He was shocked. He said: "You can make a thing a lot lighter out of aluminum than steel. Steel weighs three times as much as aluminum." "I know that," I said, "but steel is five times as strong."

Too often we get stampeded into thinking this and that and the other thing.

Professional Amateurs

WE have made a mistake by letting people think there is something sacred about engineering and research and science. They expect too much of us. . . . A research man is just a professional amateur. He is an amateur in that he is doing a thing for the first time – and it is going to be just as lousy as anything anybody ever did in his life for the first time. . . . Research is a straight case of cut and try – and I think we have oversold it as being something that can pull things out of a hat.

Dumb Animals

AS you know, bats can fly perfectly well around all sorts of obstructions with a blindfold over their eyes. When that phenomena was investigated, it was finally discovered that if the bat's ears were plugged, he couldn't fly so very well – and that if his mouth were taped shut he couldn't fly at all. . . . It has been found that the bat flies by

upersonics. . . . He gives out a high frequency wave and echoes back and he turns his head and gets either a hase balance or an intensity balance. That tells him here the object is and he doesn't go that way. . . . He an put out sound frequencies up to 90,000 per sec. We sten in somewhere under 2000 per sec and, of course, on't hear the sounds the bat hears. . . . Only in recent ears have we known even how to measure high frequency ound waves of this kind . . . but, of course, the bat is a umb animal. . . .

I have hauled pigeons to Detroit many times which had een collected from Dayton, Xenia and Springfield. They ad no gyros, no speed indicators or anything, but they ew back home all right. . . . Again, they were dumb nimals.

Take geese and ducks which come to Michigan. They et here within a day or so of the same day every year – ithout any weather department or anything. If there is north wind, they will be a day late; if a south wind, hey will be a day early; if no wind, they will be on time. . . I have always had a rule for myself: Never fly hen the birds don't, because they have had a lot of xperience. . . .

I have pointed out these things about dumb animals ecause I sometimes think we get ourselves so completely etached with slide rules and things of that kind that we egin to believe that is where engineering began – but it idn't. Engineering has been going along pretty good for long, long while.

Research

LOOKING ahead and being dissatisfied with what you are doing is most essential. . . . Anything can pass a hing that is standing still.

Research is really nothing more than the fundamental rt of sample making. The only danger I think we have n the post-war era will be lack of understanding between engineering and management as to the essentials of long-range research and sample-making. . . . We have gotten so systematized that we don't understand that getting ideas cannot be run on a mass production basis. If we don't get that out of our heads, we are going to weaken the very position we have attained today. . . . You cannot budget long-range research.

What's Wrong with Physicists

THE great trouble with the physicist, I'm afraid, is that he thinks he created the universe we are in. I don't think the physicist had anything to do with the sun and the moon and the stars. I think they were here when he arrived.

You show me a beautiful camera and rave about what a clever thing it is. Yet, you are looking at it with a couple of cameras that are a lot better than any man ever made. The physicist talks about the five senses – but he has yet to make anything that can taste or smell.

1917 vs 1943

WE were just as smart in World War I as we are now – only we didn't know as much.

We thought we were doing just as good a job – just as clever a job – in what we were doing then as in what we are doing now.

Well, you can't tell me that in another 25 years the stuff we are building today won't look exactly like the stuff we made 25 years ago – because it is. . . . We are going to have eternal progress until we learn a lot more about fundamentals than we have had a chance to learn while our business has been developing at such a rapid rate.

Fundamental Efficiencies

WE are fundamentally a power industry. Our job is to get more horsepower for less fuel. The fundamental efficiencies in the units we work with are an untouched thing. In the automobile industry we are getting only about 5% thermal efficiency out of the cars we drive around. We have 95% left to work on. Some people will pull out a slide rule and tell you we can't improve that ratio a bit. I don't believe that for a minute.

I told a friend the other day that, after the war, I think we will produce a diesel engine with 50% thermal efficiency. Right out came the slide rule and he said: "You can't do it. The second law of thermodynamics is against you." I said: "I don't know what that is. The only thing I think the second law of thermodynamics is, is that you can't push on something that is going faster than you are. (It is much more complicated than that, though.)"

I had a text book on my desk the other day – a brand new one – in which was a chapter on the diesel engine. There wasn't a single thing mentioned in that chapter I had ever heard about. If it had been written in Greek, it would have been just as intelligible to me. . . . At the end of the chapter was an example. This fellow said that if a theoretical engine went through all the calculations it could be built to produce 59 lb bmep. . . . We couldn't make one that bad no matter what we did. We could guess one with a higher brake mean effective pressure than that! . . .

I think you can calculate to find the framework in which you are going to work, but then you have to work the problem out specifically. One of the great difficulties in all our technological education is that we try to set down formulas for calculating specific devices *before* we understand the basic principles.

"85% Engines"

AT a little executive meeting recently, we got to talking about a diesel with about a 7-in. bore – which would be about half way between two engines which we already have, one with an 8½-in. bore and the other a pancake engine with a 6-in. bore.

"We couldn't make that 7-in. bore engine," I said, "unless we made a single cylinder and had at least six to eight months to work with it."

And they said: "You don't mean to tell us that when you have a 6-in. engine and an 8½-in. engine, you can't make one in between without going through all that tedious stuff of making a single cylinder engine and half a dozen or 15 or 75 pistons and injector tips and all that kind of stuff?"

I said: "I'm saying exactly that. . . . Of course, I'm not

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LESSONS LEARNED from WORL
About DESIGNING for ACCESSIBILIT

by COL. E. S. VAN DEUSEN

Ordnance Department, Tank-Automotive Center

MY objective will be to indicate the absolute necessity of a full and critical evaluation of design from the standpoints of accessibility, on the basis of critical service and maintenance factors directly related thereto.

Of widely recognized accessibility factors applying generally to mechanical equipment, there are several to which must be ascribed far greater weight in distinctly military circles than is accorded in usual commercial practice. This difference stems directly from the relative importance of operating profits evaluated on a pure dollars and cents basis. The profits of war are exceedingly difficult, if not impossible, of translation into terms of monetary exchange. Economy of human life becomes the profit motive in military operations. The sole purpose of mechanizing and motorizing our troops in the field is for the physical destruction of enemy forces and/or their will to fight, in the least possible time and at the least possible cost of our own flesh and blood.

I will attempt to show the relations of the factors involved in accessibility to this premise. These factors go far beyond a conventional placement of the components in an assembly.

The physical relationship or placement of a part or component with respect to its mating units and surrounding parts is of prime importance, determining, of course, the ease with which it can be inspected and handled. Clearances for the hands, and for the removal and return to their places of parts which require removal in servicing operations, are mandatory. Provisions for visual observation of adjustment markings, and finger or tool clearances which will simplify indicated adjustments, are also "must" items.

Any unit which requires the use of tools in the removal of covers or interfering parts, in order to make it accessible for adjustment or servicing, cannot logically be considered satisfactorily accessible. Also, any requirement for specially designed tools in the servicing, particularly the adjustment and lubrication, of a unit, detracts materially from its adaptability for military usage. Special tools are the bane of military automotive maintenance. The ideal vehicle from this viewpoint is one which can be disassembled, assembled, serviced, and adjusted completely from bumper to bumper and from the ground to the top of the body by the use of human fingers, strength, and intelligence alone. Since this is obviously impractical, the goal for military purposes should be service ease requiring only a screwdriver, pliers, and possibly a single adjustable end wrench. Say what you will of the much advertised and admittedly tremendous technological advance of the automotive industry over the past quarter-century, the modern product does not compare favorably with the equipment of World War I with respect to accessibility of critical components and accessories.

The time factor is properly divided into two phases: the hours and minutes required for actual repair and adjustment, and the time interval elapsing between required and scheduled servicing and maintenance operations. The time involved in the removal, replacement, and servicing of a unit or part is of particular importance in any military operation. Modern combat is a fast-moving situation. Any factor relating to equipment which ties up the mechanical aids to swift victory for any appreciable period of time is as deadly an enemy as the opponent himself. Under air observation and attack it is imperative that forward echelons keep on the move to prevent the destruction of equipment as a result of the mere static location of forward installations which may become known to the enemy. In the British advance from El Alamein, it was necessary to limit the stay of advance shop groups to not more than 24 hours in any one location. A longer time invited destruction of the base. Naturally, the accessibility of parts requiring repair was of extreme importance in determining how many vehicles could be repaired and returned to combat by forward elements at each stopping point. In armored warfare, the same principle holds true as was behind the well-known quotation, "He wins who gets there firstest with the mostest," at the time applied to infantry and cavalry tactics.

I submit for your consideration the fact that the improved mass-production methods which have been introduced by the automotive industry in late years have not always served the cause of accessibility. The availability of new machine processes, the use of stampings instead of forgings or castings, the wide applications of welding, and the integral types of construction often applied to units subjected to wear, while serving well the purpose of economical mass production and lowered unit costs, in many cases have resulted in an end product which leaves much to be desired in simple maintenance operations by the field soldier, who seldom has ready access to the highly specialized repair and maintenance equipment and tools available in centers of heavy population, or, in the military equivalent, base shops.

A comprehensive discussion or comparison of military versus commercial maintenance policies and objectives, together with the problems involved in each, obviously warrants separate treatment. You have heard and read presentations on this subject before various SAE groups in both the distant and more recent past. I shall not attempt to do

[This paper was presented at the SAE War Materiel Meeting, Detroit, Mich., June 9, 1943.]

AR II

Maintenance problems along the world battlefronts are difficult beyond belief. With little equipment, great determination and ingenuity, soldiers such as this mechanic in New Guinea are expected to keep vehicles rolling

★ ★ ★ ★ ★ ★ ★

Courtesy General Motors Corp.

more now than to outline briefly some of the salient points which have a bearing on my current subject.

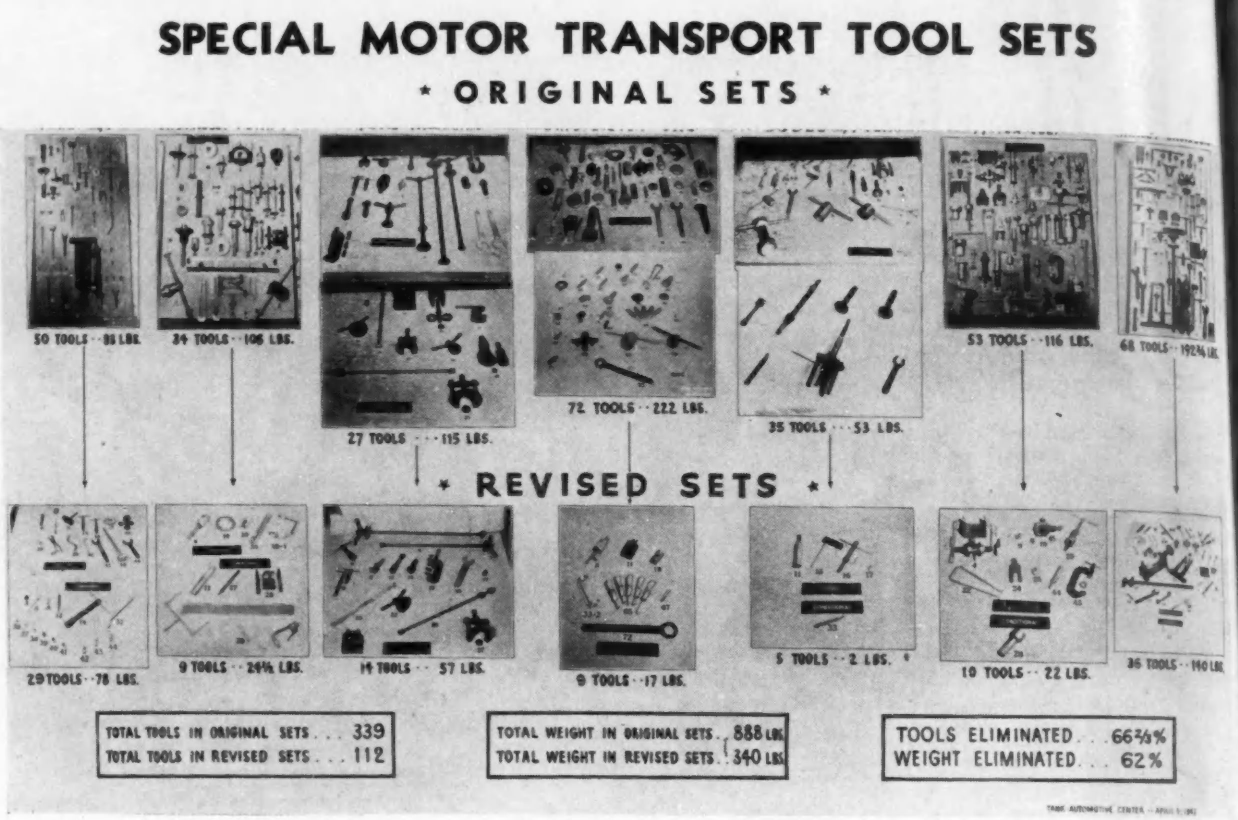
■ Service Predictable in Peace

The commercial operator, presupposing normal efficiency, is almost always in a position which permits a carefully predicted scheduling of maintenance operations. He usually knows what to expect in the line of demands on his equipment. His unknowns are generally limited to a sudden epidemic of accidents, unusual equipment failures, and uncertain weather conditions, with attendant floods or road closures, which latter, however, can be predicted to a certain pattern. He can plan his operations with a reasonable assurance that his competitor will be governed by the laws of the land and limit his competition to a peaceful, economic warfare, on the black ink and red ink basis. He can build an experience table of normal wear and tear for the particular route or locality, and provide well-equipped, fixed installations at which his maintenance work can be accomplished with fair assurance that fire and earthquake are about the only disasters which would interfere seriously with its functions. In fact, by a careful scheduling of service, adjustments, and parts replacement, based on the normal wear expectancy data accumulated as a result of actuarial studies, the commercial operator can, and many successful ones do, shorten deadline periods and prevent actual roadside breakdown. Further, under the normal peacetime economic system, he can rely upon the ready availability of parts and supplies at a convenient outlet point in the distribution chain which every reputable manufacturer must provide in order to maintain his reputable status.

The military operation under peacetime conditions naturally parallels very closely commercial operation, except for the more severe service entailed by cross-country and broken-ground routes and the training and maneuver programs with green personnel. In war, and especially in combat, however, the basic similarity ceases. Hazards of operation are increased many-fold, and the unpredictables, in addition to increased severity of service, include the imponderable direct results of enemy action reflected in deadlining or loss of vehicles, with the attendant necessity of doubling loads and extending routes so that the remaining vehicles can continue to carry the always enormous amounts of ammunition and supplies consumed by the fighting echelons. The very lives of the preponderant majority of combat personnel are dependent upon the supply service's successful operation of motor transport. Armored units are useless in an aggressive campaign, be it either attack or defense, if their armor loses its mobility.

■ Mobility Is Essential

Mobility in this global war has a meaning far greater than ever before on the land, on the sea, and in the air. Mechanized equipment has not yet been perfected to the point where it will operate indefinitely without maintenance, and even if such perfection and wear-proof qualities were within our grasp, as long as the enemy can inflict damage on that equipment, repair and maintenance must be provided. Components which may, in non-military service, be expected to serve admirably with a large factor of safety through the entire life span of the vehicle, may, in combat service, require unit replacement because an enemy sniper has put a rifle bullet or larger projectile through it. In these days of espionage and counter-espionage, he may have been instructed to sight his telescope on that particular unit because his superiors know, from the reports of their spy organization or the examination of captured materiel, that the part cannot be easily and expeditiously repaired or replaced. In order to accomplish maintenance, the crews must be able to get at the parts which require attention. It is, therefore, elemen-



Eliminating 66 2/3% of vehicle repair tools, at a saving of 62% in weight, has been accomplished by close cooperation with the manufacturers

tary that the better the accessibility which is provided to all components, the more easily can the military effectiveness of the equipment be revitalized.

It has been stated recently by several ranking officers that our problems with mechanized equipment are, to a large extent, on the way to satisfactory solutions in so far as the production phase of our war effort is concerned. But, as our equipment flows into active combat and training service, our problems of keeping it in operating condition increase, and the emphasis must pass to maintenance and repair activities, not overlooking the supply problems relative to providing the needed parts where and when needed. The phrase "when needed" means just that, without any waiting to have the part shipped from the factory. Also – and this is one of the principal points I must emphasize – when that part is on hand, any delay incident to putting it to work in place of the damaged part cannot be tolerated, because there never will be enough transport available where it is needed until our victory is won.

Maximum mobility of field forces vital to tactical success can only be attained when the full performance and effectiveness of all vehicles assigned to the operation are attained. This can be assured only by the exercise of proper and effective maintenance measures. With our forces engaged in the theaters which require dependence on overseas shipping to keep them supplied, every ship's bottom must be used with the utmost economy of space and tonnage. Deadlined vehicles in a theater of operation, as in any commercial project, are useless, and we cannot afford to ship any unneeded items overseas. It therefore is necessary to keep what we can move into these theaters in the best possible operating condition.

Any action which reduces the percentage of technical personnel and permits another rifleman, machine gunner, or bazooka bearer to bring his firepower to bear on the enemy is an essential move. If non-accessibility of a certain part of a given vehicle requires any more than an absolute minimum of time for adjustment, replacement, or servicing, the result is an unnecessary waste of manpower. A routine 1000-mile inspection, required for all military vehicles, consumes an average of 12 man-hours. The normal assignment of company mechanics in type organizations averages one mechanic to each 15 trucks. He is responsible for making the 1000-mile inspection of each vehicle under his charge at least once each month. He also assists the battalion or regimental mechanics in the 6000-mile inspections given at least once each six months, at a normal rate of three or four a month. His other duties include the instruction of drivers and assisting them in their daily inspections, trouble-shooting and emergency repair, and adjustments as necessary. He does not have any spare time to waste in coaxing a hidden or hard-to-get-at part out into the open so it can be lubricated or adjusted, and he doesn't have more than the minimum tools with which to do his work. Space in the trucks of an operating company must be used for carrying ammunition, subsistence, and other supplies, rather than for an elaborate set of tool equipment. His job cannot be accomplished unless he can see, feel, and manipulate the parts requiring attention. It must also be clearly remembered that parts, lubrication fittings, and so forth, which are not readily accessible,

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ENGINES for TANKS

by LT.-COL. R. J. ICKS

Ordnance Department

STEPPING boldly into the thick of three long-debated engine controversies – liquid versus air cooling; diesel versus carburetor type; and radial versus V- or in-line cylinder arrangement – Col. Icks comes out flat-footed in this paper for the aircooled horizontal- or V-type diesel engine as the one that most nearly approaches the ideal tank engine.

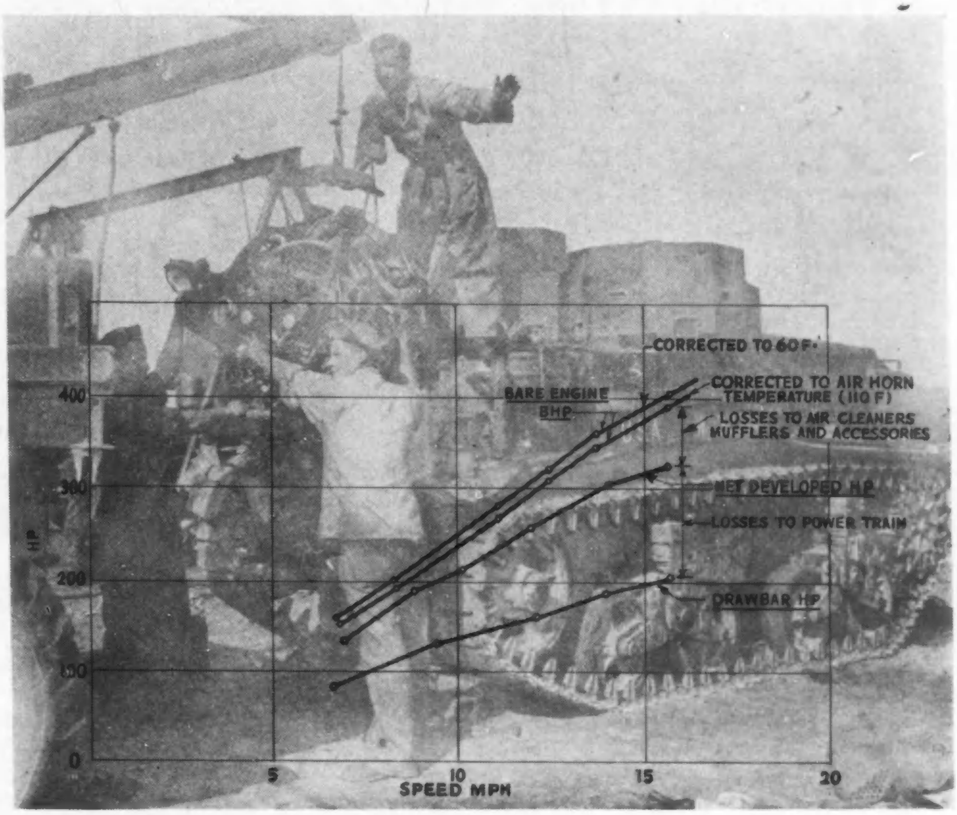
The injection system of this ideal engine, he specifies, should be able to handle a range of fuels from diesel fuel to 80-octane gasoline. It also should have a high enough horsepower-to-weight ratio to overcome the losses due to accessories and power train, and should have an air cleaner which really cleans. To support his choice he presents cogent arguments based on military requirements.

THE development of engines for tanks has been almost entirely a matter of adaptation of engines originally built for other uses. There were many reasons for this condition, not the least of which was the lack of interest on the part of industry in developing a specialized engine for tanks in view of the limited orders which the pre-war economy years permitted us to place. As matters turned out, it was just as well, in that we probably have been able to procure more tanks than we could have, had we been limited to only one type of engine for this purpose. However, while we have quantity, we do not yet have the quality or performance that is possible and desirable.

Back in 1932, the Ordnance Department, in searching for the ideal tank engine, installed a Continental radial type, aircooled aircraft engine in the T2E1 combat car. Subsequent tests in that and later vehicles led to the adoption of this type of engine for tank use, not because it was the ideal engine but because it was the nearest approach to the ideal among engines which were likely to be commercially available in an emergency.

When the National Emergency began, back in 1939, tank production was based on aircooled radial engines, but rapidly accelerated production forced the adoption of

[This paper was delivered at the SAE War Materiel Meeting, Detroit, Mich., June 9, 1943.]



What takes place in the engine compartment of an M-3 Medium Tank: Chart shows analysis of horsepower losses, makes clear how different are rated horsepower and useful horsepower – pointing to the need for high horsepower to weight ratios

other types of engines in 1941, so that today we have in our tanks aircraft-type gasoline-operated radial, aircooled engines; similar engines of the diesel type; dual liquid-cooled commercial automotive engines of both gasoline and diesel types; a multiple bank arrangement of five commercial liquid-cooled automotive engines, and a single liquid-cooled V-type engine of modified aircraft design.

It is my intention to discuss three fundamental arguments concerning tank engines, in an effort to make clear that the needs of the military service for such engines have not been met in engines which have been and are commercially available, excellent though some of them are for normal commercial uses. These three arguments are:

1. Horsepower to weight ratio
2. Air versus liquid cooling
3. Diesel versus gasoline engines

Following the presentation of these arguments, it is my intention to indicate to you the Ordnance Department's idea of what constitutes an ideal tank engine.

Tanks possess three major overall characteristics. These are: fire power, mobility, and protection. Of these, only the feature of mobility is of concern when engines are discussed, although fire power and protection are affected when the vehicle lacks mobility. Mobility is keyed basically to the motive power provided for the vehicle. Superior mobility requires a reserve of power for all types of conditions likely to be met and this can be obtained by having in an armored fighting vehicle a high ratio of engine power to vehicle weight. Tanks of the World War I period had ratios of horsepower per ton of weight of about 4 or 5. Most European tanks today seldom exceed 10, while American tanks exceed this figure slightly. Contrast this with the hp to weight ratios of standard commercial automobiles, which never are called upon to undergo operations as severe as those encountered with tanks. The following chart will make this clear:

Vehicle	Loaded Weight, Tons	Bhp	Hp per Ton
Buick 40	1.825	110	60.3
Half Track M3	9	142	15.8
Jeep	1.562	55	35.2
Light Tank M3	15	250	16.6
Light Tank M5	15.9	300	18.9
Medium Tank M4A1	33.7	425	12.5
Medium Tank M4A3	34.3	500	14.5
Heavy Tank T1E1	62	775	12.5
36-Passenger Yellow Coach	11	165	15.0

Not only does a higher ratio increase mobility, but it also contributes to reliability and protects against rapid depreciation, assuming, of course, a proper type of transmission is used.

■ Adequate Power Needed

The horsepower-per-ton ratio is important because of its effect on several other features concerned with mobility, notably speed, acceleration, steering, and slope operation. High ratios are necessary in order to pull vehicles through bad terrain and to drive them over obstructions in their path. A reserve of power is extremely important in order that demands may be made upon it in such emergencies.

Speed is necessary to out-maneuver an enemy, to reach vulnerable spots in an enemy line or on an enemy vehicle, to take full advantage of break-throughs that may occur, or to elude superior enemy forces after delivering a hard blow against them. Acceleration is important to a combat vehicle for the same reasons that speed is essential. High speed reached slowly does not give the effect desired. Quickness of movement is determined by the acceleration characteristics of a vehicle.

High horsepower per ton is necessary to strategical maneuverability as contrasted with tactical maneuverability, because of its effect on column movements, by enabling the maintenance of a constant speed despite terrain features that may be encountered. This reduces the accordion effect which takes place when a column of underpowered vehicles operates in hilly country or on roads with varying surfaces. A single amored division on one road occupies a road space of some 90 miles, and it is apparent how greatly this could be elongated by the accordion effect.

A discussion of power in a tank engine must be tempered in that *useful* power is the quality on which an engine should be considered. Also, if an engine's power is developed at a high rated speed, the wear characteristics are likely to be poor. Conversely, if the power is developed at a low rate of speed, the size and weight of the engine become excessive.

Another important consideration in the performance of a combat vehicle is the torque curve of the engine. If this curve is of the proper shape, the vehicle is allowed to continue forward motion under load conditions which otherwise would require changes in torque ratios by shifting gears. Such changes may slow down column movements or cause the vehicle to become immobilized in places that it could negotiate if additional torque were available. A flat torque curve with a peak of about ⅗ rated engine speed is generally desirable.

During the course of an investigation at a proving ground with several light and medium tanks, it was found that in no case could a tank negotiate grades of over 2% in fifth gear. It is evident from this that most cross-country operation would be in third or fourth gear. In this same investigation, it was found that from 80 to 90 gear changes were made every 10 miles. It was evident from this that the horsepower to weight ratios in our combat vehicles are in need of increases.

■ Drawbar Horsepower Criterion

As already stated, there may be considerable difference between developed horsepower and useful or drawbar horsepower. Horsepower ratings are usually stated for an engine without accessory equipment operating under an atmospheric temperature of 60 F and a barometric pressure of 29.92 in. of mercury. However, other standards exist, and there is such a wide variation in laboratory practice and regional engine testing that unless all testing conditions are stated there is no assurance that ratings are comparable. As you know, increased power output can be obtained in several ways, one of which in common use is unduly low water jacket temperatures.

The chart on page 39 shows for an actual tank engine the output under standard conditions with and without accessories and with an entering air temperature of 110 F. Such temperatures, we have learned in the past two years, are perfectly possible under some conditions of warfare. This chart illustrates, in part, what takes place in the engine compartment of a combat vehicle. In a rear-engine vehicle the air entering the engine will be at least 40 to 60 F above ambient. A temperature rise of 100 to 125 F is not uncommon, and good performance even in mild temperatures requires the best cooling obtainable in order to develop proper power output. It can be seen from this

chart that rated horsepower and useful horsepower are far different and point to the need for high horsepower to weight ratios for combat vehicles.

Again referring to the investigation at a proving ground on hp to weight ratio, it was the conclusion that at least a 50% increase in hp per ton was required for American tanks for better handling, maneuverability, and grade performance.

Although not a part of my subject, it must be mentioned in passing that mobility and performance are affected by the transmission used. There has been a definite trend in the past two years toward automatic types of transmissions. Thus far, only one of our light tanks has such a transmission, but several additional experimental types are in process of test. These transmissions have a bearing on the delivered or drawbar horsepower and the smoothness of that delivery.

The second major argument concerning tank engines is the matter of cooling. This again stems from the lack of completely suitable commercial engines in years gone by because air cooling was not in use in heavy-duty engines of that type.

One of the major obstacles to the use of liquid-cooled engines in combat vehicles is the greater airflow required and consequent difficulty involved in their cooling. The reason for this is that whereas the fins of aircooled engine cylinders in operation will rarely drop below the perfectly satisfactory temperature of 350 F, 225 F is usually considered the practical limit for radiator temperature in the cooling system of a liquid-cooled engine. Assuming operation at an ambient temperature of 125 F, the water-cooled engine permits only a 100 F temperature differential while the aircooled engine has a temperature differential of 225 F in which to work.

On the other hand, successful cooling of finned cylinders requires both an adequate flow of cooling air and efficiency baffling of the individual cylinders. Much study has been devoted to baffling of finned cylinders, notably by the NACA, and this feature may be considered no longer subject to radical change. Fan capacity may be adequate but it is often found that proper cooling is still not realized because inlet and outlet passages are so tortuous and obstructed as to reduce the airflow below the critical value. Unless care is taken to avoid air recirculation, cooling efficiency may be seriously reduced thereby. Too, high fuel temperatures may induce vapor lock and require auxiliary equipment to overcome that effect.

Much can be accomplished by fairing inlet and outlet air passages and thus reducing resistance to airflow. Improved efficiency can often be realized by preventing eddies through the use of guide vanes which direct the flow of air and prevent its continued rotation. The following table shows the engine and fan characteristics for several aircooled engines used in combat vehicles. It also shows effects in some cases of more than one type of fan and illustrates, as well, the point of useful as contrasted with developed horsepower.

Engine	Bhp	Fan Drawing No.	Diameter, In.	Hp Consumed	Maximum Rpm
Continental W670	250	D7939	34	85	2400
		D32894	30	35	2400
		D33156	30	20	2400
Guiberson T1020	240	D32894	30	30	2200
		D33156	30	15	2200
Wright Continental R975C1	420	D34110	34	35	2400

In any liquid-cooled powerplant three variables are involved which must be properly balanced for efficient cooling:

1. Airflow
2. Coolant flow
3. Radiator surface

Bearing in mind that airflow obstructions must be endured and much larger air volume circulated, it is obvious that greater care must be taken to build up the greatest possible efficiency of fan and air passages.

Radiator cores should preferably have generous air passages for ease of cleaning and to safeguard against clogging with dirt. In rear-engine installations, location of the radiator and fan at the extreme rear results in a minimum of radiator clogging.

Usually there is little choice in the matter of using a suction or a pressure fan. Whenever such a choice is possible the suction fan is to be preferred for use with a radiator of any conventional type. The reason for this is that such air arrangement permits normal straight-line flow normal to the radiator face. The discharge from a pressure fan, on the other hand, involves a considerable amount of rotation in the plane of the radiator. Unless this is rectified by the use of straightener vanes, turbulent flow and loss of efficiency will take place between fan and radiator.

In any type of combat vehicle, particularly with tanks, the difficulties of cooling are tremendous, because the engine virtually is enclosed, particularly in action. Either air cooling or water cooling, properly designed, is satisfactory, except that certain difficult military situations likely to arise point to air cooling as being the more satisfactory of the two.

Leakage, puncture of the radiator by enemy fire, clogging of radiators from without by dust, dirt, and twigs, or restrictions within the system for the same reasons, are real problems. One of the most urgent current demands from the field is for steam jennies to clean out radiator cores. In many theaters of operations water is neither available nor suitable for use, aside from the ability of the crew to replenish water supply in combat. Maintenance difficulties due to vibration, and other factors, all militate against the use of water-cooled engines. The problem of liquid-cooled engines under winter conditions likewise is a serious one.

■ Air Cooling for North

A letter I recently received from an Ordnance officer in Russia said, "If people could see the difficulties involved in handling liquid-cooled tank engines in a Russian winter, the argument in favor of air cooling would be settled once and for all."

The additional weight involved in water cooling is another argument against its use. This is a major item affecting the characteristics of both mobility and protection. The Ordnance Department would prefer a ton of weight in additional armor to a ton of dead engine weight. Differently expressed, for equal horsepower and performance characteristics, an engine weighing one ton more than another automatically costs us one ton of protection if gross weights are comparable.

Most of these difficulties I have outlined are peculiar to military operations and are not normally met with in commercial practice. However, since the engines in a combat vehicle are almost completely enclosed, it is

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Technical IDEAS for ENGINEERS

Progress

In Air Service Ends 'Model' Transport

by CHARLES FROESCH
Eastern Air Lines, Inc.

▪ Metropolitan, June 17

(Excerpts from paper entitled "Fundamental Requirements of Post-War Transport Airplanes.")

IT is safe to say that the day of transport airplane standardization, as we have known it for the past seven years with the Douglas DC-3, is over. As we grow we must provide a public service ranging from local passenger service operation to long-range passenger service, as well as air cargo facilities for the shipper of merchandise requiring speed of movement.

Obviously, we cannot furnish this wide range of service efficiently and economically with a single type of airplane or even possibly two, and expect to progress. We can, therefore, contemplate the operation of five distinct types of airplanes in scheduled air transport which will probably come quite close to the following general definitions:

1. *Feeder Service.* An airplane of small capacity designed to stop every 25 or 30 miles to pick up passengers, mail, and express for transportation between small communities or transfer to main line points.
2. *Local Schedule.* A larger airplane designed to stop every 100 to 200 miles depending upon the territory served and connect with the feeder service.
3. *Limited-Stops Service.* An airplane of excellent speed performance and approximately twice as large as the local schedule airplane.
4. *Long-Range Operation.* A large airplane with maximum speed performance and best possible L/D speed for economy of flight. Designed for 1000 miles between stops and upward.
5. *Cargo Service.* An airplane designed as simply as possible, able to stand a lot of abuse, virtually a "flying box car" both in general appearance and size.

Table Shows Characteristics

I am disposed to believe that the basic characteristics of these airplanes should follow the specifications in Table I. (p. 68)

It will be noted that airplanes 1, 2 and 5 are listed as bimotors, airplane 3 as either a bimotor or quadrimotor, and airplane 4 as a quadrimotor only. This is dictated by their size for airplanes 1 and 2 and lowest operating cost per ton-mile for airplane 5.

A high wing location was selected for airplane 1 because, with frequent stops, reduction in ground time is most important

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Vivid Vistas Bid Engineers To Aeronautics

by R. S. DAMON
Republic Aviation Corp.

▪ Metropolitan, May 20

(Excerpts from paper entitled "Future of Aviation.")

AT no time has the engineer in aviation stood on greater thresholds of opportunity. At the end of the last World War, the fastest pursuit plane had a top speed of 180 mph. Twenty years later our commercial airliners were cruising at that speed and one newer model, not yet in production, exceeds it by nearly 50%. Before this war ends we should have pursuit airplanes in production and in combat with speeds exceeding 450 mph. If we merely extrapolate the future in accordance with the past we should have transports cruising at better than 400 mph within 20 years and coming close to it by the period surrounding 1953.

Private airplanes of the executive type will approximate the performance of airliners; however, I feel that the more frequent schedules on transport routes and the expansion of routes themselves both in the United States and over the world to all the various cities and communities irrespective of size will tend to make such airplanes more and more confined to service off such airline routes.

Strictly private planes for the man in the street will undoubtedly increase tremendously in numbers and their performance will be substantially better as our engineering and manufacturing technique progresses.

Engineering-wise there are so many developments, some of them so secret that they may not even be mentioned, that our 1941 pre-war planes will be to those of 1953 as the 1916 Model T Ford was to the 1928 Model A. These improvements start with the fundamentals of aerodynamics, including the suppression of all external protuberances including rivet heads, air intakes and exhaust outlets. The smooth "flying wing," suppressing even the fuselage and tail itself, is an example and will prob-

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Iron Extraction Now Reaching High Peak

by C. H. LENHART
Kaiser Steel Plant

▪ Southern California, May 1

(Excerpts from a paper on iron production.)

DURING the early development of the iron industry in England, the metal was obtained by heating a mixture of ore and charcoal, probably in a flat-bottom furnace or forge, until there had collected a small body of pasty metal which was then drawn and worked by hammering. Finally the iron makers of Europe succeeded in producing iron that would melt in the furnace and permit casting. This they accomplished in a new type of furnace built of masonry which enclosed a shaft or vertical opening in the form of two truncated cones placed end to end, simulating the lines of the modern blast furnace.

About the year 1880 very rapid advancement began to be made; the size of the furnaces began to increase and modern improvements were developed and installed. The modern blast furnace represents a pyrochemical process for the extraction of iron from its ores, just now attaining its highest state of development.

Principles of Operation

The most important occurrences in the furnace are: (1) Reduction of iron ore to metallic iron; (2) development and utilization of heat; (3) formation of slag.

The fundamental principles of the process have remained the same because experience has demonstrated that it is most practical. All changes which are made are done with a thought toward increasing production and decreasing costs.

Essentially, the furnace proper controls the entire process and is carried out by charging in the proper proportions – through a specially constructed opening in the top of the furnace – alternate layers of coke, iron and limestone, while heated air is simultaneously blown in near the bottom through openings called tuyères.

The nitrogen of the air along with the products of combustion (carbon monoxide, carbon dioxide) from the fuel and from the calcining of the limestone pass up through the stock of the furnace (coke, iron ore, limestone) creating a reducing atmosphere which reacts with the iron ore (oxides) and steals away its oxygen content, leaving the

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Briefed from Papers given at SAE SECTION MEETINGS ★

●Higher Pressure Results In Lower Tubing Weights

by PHILIP DE BEIXEDON
Douglas Aircraft Co., Inc.

▪ Southern California, April 16

(Excerpts from paper entitled "High Pressure Hydraulic Systems.")

IN general, there are three types of hydraulic systems. One which is not very common is called a manually-operated by-pass system. In this system the fluid from the engine pumps is controlled by a by-pass valve which is either manually operated or connected mechanically to the selector valves. When the by-pass valve is open the fluid circulates freely under no pressure between the engine pumps and the reservoir.

Another type of hydraulic system, one which is most commonly used, contains an automatic by-pass valve or regulator or unloading valve, which maintains pressure in an accumulator at all times. The function of the regulator or unloading valve is to by-pass the fluid to the reservoir when the pressure in the accumulator has reached the operating pressure. When the pressure is drawn from the accumulator for the operation of a unit, this regulator valve closes, allowing the pressure once again to build up in the system.

The third type is a system employing variable displacement pumps. In this system, there are no by-pass or unloading valves. The pressure in the system is controlled directly by the pumps. When no fluid is needed to operate the units, the pumps automatically shift in such a manner that the output is reduced to zero; conversely, as soon as fluid is needed to operate a unit, the pumps shift back and deliver the required amount of fluid at the required pressures.

The question that has caused a considerable amount of discussion of late is the relative merits of high-pressure versus low-pressure systems. When we refer to low pressure, we refer to systems which operate in the range of 800 to 1000 psi up. At the present time, systems are operating successfully at 3000 psi. As you probably know, the amount of fluid flowing for a given power varies inversely with the pressure, and the available pressure drop through the lines at equal efficiency varies directly with the pressure. Therefore, increasing the pressure in the system would reduce the flow and hence the size and consequently the weight of nearly all of the tubing used in the hydraulic system.

As we know, the load developed by a cylinder is equal to the area times the pressure. Therefore, as the pressure is increased, the area can be decreased for the same

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Prop Selection Is Requirement At Early Stage

by THOMAS B. RHINES
Hamilton Standard Propellers Division, United Aircraft Corp.

▪ Wichita, May 5

(Excerpts from paper entitled "Notes on the Selection and Installation of Aircraft Propellers.")

AIRCRAFT propeller selection and installation are by nature a problem of coordination and cooperation among several separate organizations. The propeller manufacturer, airplane manufacturer and engine manufacturer are always involved, and in many cases the vendors of accessory equipment may influence the ultimate propeller selection for an airplane.

A brief outline of some of the points that must be evaluated in propeller selection is useful to clarify this point. While the considerations involved are many, the following are among the most important:

1. Aerodynamic performance
2. Propeller weight and size
3. Airplane - engine - propeller vibration characteristics
4. Detailed installation requirements
5. Propeller structural loads
6. Operating loads
7. Blade angle range requirements
8. Rate of angle change
9. Availability in production

Several of the above categories are primarily the concern of the propeller manufacturer. A particular example lies in the

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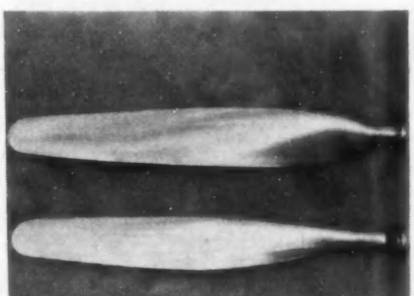


Although advantageous for engine cooling, the wide shank blade, above, adds weight of itself and for heavier mechanisms to twist the blade

●World Shrinks as Air Transportation Develops

by MILTON H. ANDERSON
Northeast Airlines, Inc.

▪ New England, May 20

(Excerpts from paper on the future of Air Commerce)

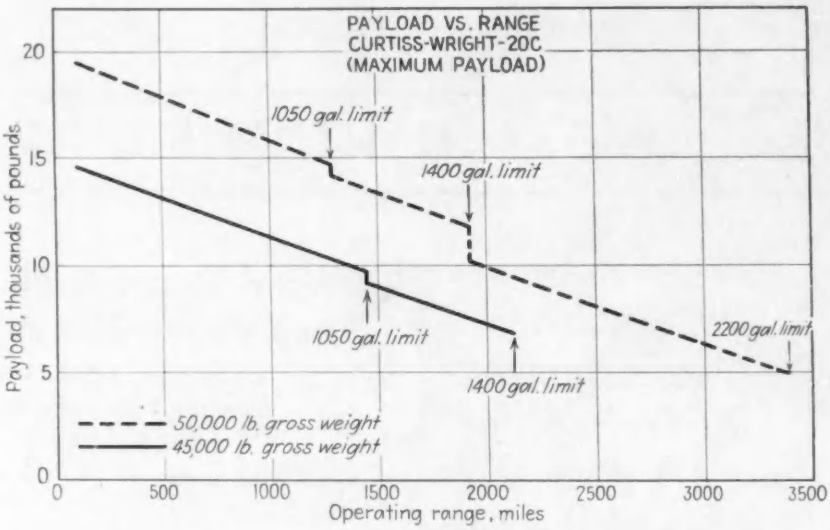
WARTIME cargo service has given me an opportunity to see at first hand the problems that will be presented for future solution in order to establish the dependability that is necessary to insure the success of transatlantic air service. The first of these problems has to do with routes. Since the words "global" and "great circle" have become popular, the maps with which we were once familiar have been discarded and for them have been substituted those types of maps which give more clearly a picture of the distance between points.

One is the "polar projection." It is a map drawn from the point of view directly above the pole. Three-quarters of the world's population lives in the northern hemisphere and the shortest distance between points on opposite sides of the earth in the northern half of the world is over the polar regions, not by water as previously traveled. A great many of the routes that will be operated after the war will therefore be flown over the north polar area.

Northeast Airlines has filed application with the Civil Aeronautics Board for a certificate to operate passenger, mail, and cargo service between Boston and Moscow, with service to Iceland, England, Norway, Sweden, Holland, and other countries on the continent. It will be noted that the shortest distance between Boston and Moscow lies over Northeast's presently operated route through Maine and Eastern Canada and would pass near Greenland and Iceland. I am convinced by what I have seen over Greenland and Iceland, as well as over the other areas now served by us, that suitable landing bases will be available for airline operation after the war. The biggest problems presented by an air route in this area are those associated with the weather.

There is a great deal of fog, and whenever a bad weather area is encountered there is a probability of picking up ice in the clouds. These problems are, however, relatively of minor consequence. The radio development that the war has fostered has shown us the way to land solely by instruments and, of course, we have been flying by instruments for many years.

If you have read the aviation columns recently, you will know that Northeast Airlines has filed application with the CAB for a mail, passenger and cargo service, utilizing helicopters and serving some 400 communities in the New England area. Our plans at this time may appear to be visionary. After witnessing a demonstration flight of



Payload that the 20-C would carry when operated at low cruising powers and speeds to keep fuel load to a minimum. The following assumptions were made:

(1) For various lengths of flight, indicated below by fuel tank capacity, the weight (lb) of airplane, equipment, etc., would be as follows:

	Fuel Capacity, gal		
	1050	1400	2200
Empty Weight	27,900	27,900	27,900
Residual Fuel & Oil	120	120	120
Crew	400	400	600
Supplies and Misc. Equipment	50	250	250
Fuselage Fuel & Oil Tanks	—	—	1,330
Extra Wing Tanks	—	234	234
Navigator's Station	—	—	164
TOTAL	28,470	28,904	30,598

(2) Reserve fuel based on the following:
- **(a) No wind.**
- **(b) Distance to alternate airport 200 miles for a 200-mile run, 300 miles for a 2000-mile run.**
- **(c) Three-quarter hour reserve on reaching alternate airport.**

(3) Cruising altitudes between 3000 and 10,000 ft

the helicopter, we are convinced that it has a practical application to provide air transportation to communities which do not have adequate airports for conventional type airplanes.

We conceive of a service to be provided from the roofs of post office or railroad stations or from open spaces in the center of cities, with this airplane which can take off and land vertically. We believe that other air transportation companies will follow these same ideas and that eventually this country can be provided with air transportation of mail and passengers even to the smallest communities. The operation of a service like this would also go a long way toward absorbing the flight personnel who will be released from military service after the war is over. It is quite probable that the service would not be economically self-supporting. The advantages are, however, so numerous that Government subsidy should be entirely in order.

This world has shrunk as a result of the development of air transportation. Let us hope that no shortsighted or timid policy of Government will stand in the way of our airlines taking advantage of this development and thereby prevent America from being first in world air commerce.

Steel Ordering Requires User-Mill Cooperation

by W. A. SAYLOR
Fontana Steel Plant, Kaiser Co.

▪ Southern California, May 1

(Excerpts from paper entitled "Talk on Metallurgical and Open-Hearth Aspects of the Fontana Plant.")

NO steel plant is any better than its reputation. This reputation, if built on a solid foundation, is arrived at by many factors, the most important of which, from a consumer's standpoint, is "quality."

In my experience, a customer is generally interested in three things. First: How soon can I get it? Second: How much does it cost? Third: Does its quality satisfy us? Therefore, not knowing too much about the first two, I would like to give a combination open-hearth and metallurgical opinion on the latter – namely, quality.

Most of the improvements made in recent years have been made with the thought ever foremost in the engineers' minds that

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SECTION ROUND-UP

Baltimore . . . Conditions and problems the motor transportation industry is facing in connection with engines, what difficulties to expect and how to remedy them, and what can be done to prevent their recurrence were all discussed by Leonidas Doty, Jr., engineer in charge of Automotive Division, Koppers Co., American Hammered Piston Ring Division, when he presented "Wartime Maintenance, Rings, Pistons and Cylinders," on May 13.

Canadian . . . Section year terminated with a meeting in Oshawa. Those who attended were cordially welcomed by the host of the occasion, Canadian Section's member of longest standing – Col. R. S. McLaughlin, president of General Motors of Canada, Ltd. Major N. B. Capes, staff officer of the Director of Mechanical Maintenance, Department of National Defence, was guest speaker.

Cleveland . . . Section held a technical meeting on May 10 at the local war plant of The Weatherhead Co.

Detroit . . . E. W. Austin, retiring chairman, was presented on May 19 with a gift from the members of the Section to mark the end of his term of office.

Indiana . . . Subject of May 20 meeting – "Tank Powerplants," by Major Howard R. Hammond, Armored Force Board, Fort Knox, Ky. On the "restricted" list, this paper proved to be one of the most interesting delivered during the year.

Kansas City . . . Civil Aeronautics Administration's Frank M. Bonder told members and guests at the May 24 meeting about the "Probable Trend of Post-War Aircraft Powerplant Installation Design."

Metropolitan . . . Fundamental Requirements of Post-War Transport Airplanes were presented by Charles Froesch, Eastern Airlines' chief engineer, on June 17.

Milwaukee . . . Annual Ladies' Night Party was held at the Westmoor Country Club – cocktails, dinner, entertainment and dancing until 12:30 a.m.

New England . . . The section had as its May 20 speaker a "Million-Miler" (over 10,000 hr in the air) and the first man to fly an all-cargo air transport over the North Atlantic – M. H. Anderson, vice-president of operations, Northeast Airlines, Inc.

Northern California . . . A paper entitled "Modern Filter Developments As Applied to Fuel and Lube Oil Systems of Diesel Engines" was presented on June 8 by Charles A. Winslow, Winslow Engineering Co. head. . . . Ring belt deposits and their elimination are a chemical problem and have been solved by the inclusion of the proper chemicals in lubricating oils. This was the theme of Dr. G. H. Denison, Standard Oil Co. of Calif., who presented a paper on May 11. J. O. Clayton, also of Standard Oil, was co-author.

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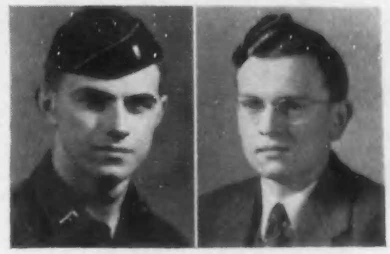
Chairmen Who Led Student Branches In 1942-43

CORWIN D. McLEAN, a second lieutenant in the Corps of Engineers, entered active duty on May 29. A student in mechanical engineering at Oregon State College, Lt. McLean taught part time in general and mechanical engineering this past year.

ANDREW N. SMITH graduated last month from Ohio State University's Department of Mechanical Engineering. During his senior year he was an assistant in the Mechanical Engineering Department. He is affiliated with Kappa Kappa Psi and Tau Beta Pi.



Corwin D. McLean — Oregon State; Andrew N. Smith — Ohio State

George J. Moncher — CCNY; Albert J. Miller — U of Wisconsin

GEORGE J. MONCHER'S leadership played an important part in obtaining an SAE Student Branch charter at the College of the City of New York. One of the top men in his class, Mr. Moncher's graduation at the end of this semester precluded the possibility of his guiding the Branch for another year.

ALBERT J. MILLER received his B.S. Degree from the University of Wisconsin and is now with Pan-American Airways, as a trainee in the company's shops at La Guardia Field, Long Island, N. Y.

PATRICK ROY DWYER recently graduated from the University of Detroit, where he majored in electrical engineering. Mr. Dwyer expects to be called to active duty in the U. S. Navy.

JACK R. DOUGLASS, who headed the SAE Student Branch at Oklahoma Agricultural and Mechanical College for 1942-43, will be called to active duty as an ensign in the U. S. Naval Reserve upon completion of his engineering degree in August.

Patrick Roy Dwyer — U of Detroit; Jack R. Douglass — Oklahoma A&M

A. R. Puccinelli, Jr — NYU; Lewis C. Pascoe — GM Institute

ALFRED R. PUCCINELLI, JR., student in aeronautical engineering, graduated from New York University last month and is joining Pan-American Airways' Atlantic Division staff as apprentice engineer. He has worked as lead man on final assembly and also as draftsman for the B. H. Aircraft Co.

LEWIS C. PASCOE graduated from General Motors Institute this year and is now employed in the Engineering Department of the Chevrolet Motor Division. GMI's Student Branch chairman for 1942-43, Mr. Pascoe was vice-chairman of the Branch the previous year.

CHARLES M. ZIMNEY, senior aeronautical engineering student, graduated from South Division High School, Milwaukee, in 1939. After working for one year he entered Purdue University. He has been a member of the SAE Student Branch since his freshman year.

DAVID S. KAUFFMAN entered the Agricultural and Mechanical College of Texas in 1939 to study mechanical engineering. A member of the Enlisted Reserve Corps, activated in March, 1943, he was permitted to remain in school until the end of the semester.

Charles M. Zimney — Purdue; David S. Kauffman — Texas A & M

John D. Stanitz — M.I.T.; Dick F. Boyd — U of Oklahoma

JOHN D. STANITZ received his Master's Degree in Mechanical Engineering from Massachusetts Institute of Technology in June. Co-author of an NACA Technical Note on the air capacity of high-speed engines, he is now working for the National Advisory Committee for Aeronautics in Cleveland.

DICK F. BOYD, a graduate in aeronautics, mechanical engineering, University of Oklahoma, is now an Air Corps Engineering Cadet. He received the Dad's Association Award as the outstanding senior man in the University.

About SAE

J. C. Londelius, chief engineer in charge of powerplant, Douglas Aircraft Co., Inc., who has been stationed in Africa for the past year

PYKE JOHNSON, president of the Automotive Safety Foundation, spoke on "The Challenge of Wartime Traffic," at a Southern Safety Conference. "An amazingly efficient job is being done in moving people and goods by the great mass transportation agencies of the country, but they are reaching their peaks, and only the vast reservoir of millions upon millions of passenger cars and trucks remains as the bulwark which will stand up against the growing pressures until manufacturing genius, working night and day can bring in new processes and new materials," said Mr. Johnson. This address was printed in the *Congressional Record*, March 25, 1943.

RAYMOND G. BENNETT, formerly research engineer, Lanova Corp., Long Island City, N. Y., is now a lieutenant (jg), E-V (S), USNR, and is stationed at the Naval Engineering Experiment Station, U. S. Naval Academy, Annapolis, Md.

CAPT. HARRY R. JACOBSON, formerly assigned to duty with the Tank-Automotive Center at Detroit, is now on duty with the Small War Plants Branch, Purchases Division, Headquarters, Army Service Forces, Washington. Before entering service in May of last year Capt. Jacobson was president of the Universal Trailer Sales Corp., New York City.

Formerly technical editor of the Chrysler Corp. of Canada, Ltd., Windsor, Ont., Canada, **THOMAS O. MANTLE** has accepted a commission in the Royal Canadian Navy. His address is the Royal Canadian Naval Volunteer Reserve, Halifax, N. S., Canada, and he is an engineer lieutenant.

ROBERT P. VAIL has joined the Cabot Co., Pampa, Tex., as assistant chief engineer. He was formerly head of the mechanical engineering department of the Pantex Ordnance Plant at St. Francis, Tex.

JOE M. MILLER has been transferred from the Infantry Division to the U. S. Army Air Forces, Warner Robins Depot Control Area Command, Ga., where he is head automotive adviser.

JOHN E. KELLY is in cadet training, U. S. Army Air Forces. He is stationed in the 61st College Training Detachment at the University of Vermont, Burlington. In civilian life Mr. Kelly was a tool designer at the Lawrance Engineering & Research Corp., Linden, N. J.

WILLIAM A. BENSER has been transferred from the Langley Memorial Aeronautical Laboratory to the Aircraft Engine Research Laboratory, by the National Advisory Committee for Aeronautics.

GEORGE K. FEINBERG, who had been proprietor of the Automotive Tire & Service Co., Cambridge, Mass., is now a second lieutenant in the U. S. Army. Lt. Feinberg is stationed at Fort Wright, N. Y.

E. P. BLANCHARD, an executive of the Bullard Co., Bridgeport, Conn., addressed a mass meeting staged by the Bridgeport Jewish War Veterans recently. Mr. Blanchard, who has been associated with the work of the Ordnance Association and with the manufacturing of munitions, and for two years chairman of the Production Advisory Committee of the SAE, spoke on the contribution that industry has made to the war program.

ARTHUR R. PROUTY, who had been a draftsman for the Petroleum Heat & Power Co., Stamford, Conn., is now warrant officer (jg), U. S. Army.

Formerly a lieutenant in the U. S. Navy, **K. A. AYERS** has been promoted to lieutenant commander.

MILLER McCLINTOCK, president, Mutual Broadcasting Co., suggested in a recent speech to the Philadelphia Rotary Club, that official citations, comparable to the Army-Navy "E" Awards, be given by the Office of War Information to advertisers and advertising agencies for effective dissemination of war information through advertising.

R. DIXON SPEAS, American Airlines research engineer, was awarded first prize for the best research conducted by airline employees during 1942 which has a practical application to airline dispatching or meteorology. Mr. Speas' paper was entitled "Presentation of Meteorological Information to Flight Personnel."

LESLIE C. SMALL, JR. has been promoted from layout draftsman to designer of aircraft engines, Pratt & Whitney Aircraft, Division of United Aircraft Corp., East Hartford, Conn.

JACK CHESTER has joined Defence Industries, Ltd., Montreal Works, as supervisor of transportation and garage maintenance.

LT-COL. C. G. KUSTNER, Corps of Engineers, has been transferred from Fort Leonard Wood, Mo., to Camp Abbot, Ore.

Formerly assistant physicist and engineer, U. S. Navy, Bureau of Ordnance, Washington, **ENSIGN RALPH E. CARLSON** is now electrical engineer and physicist, Commander Service Force, F. P. O. San Francisco.

Recent Bendix-Westinghouse Appointments

Until recently superintendent of rolling stock for the Department of Street Railways, City of Detroit, **FLOYD L. WHEATON** has joined the staff of the Bendix-Westinghouse Automotive Air Brake Co., according to an announcement made by the company. With headquarters in the general offices at Elyria, Ohio, Mr. Wheaton will assume the post of manager of field activity. Bendix-Westinghouse also announced the appointment of **I. F. NELIS** to head the organization's retail sales department. Mr. Nelis has been with this company since 1926. He was assistant retail sales manager.

Floyd L. Wheaton

I. F. Nelis

Members . . .

Edward Warner, past-president of the Society, the fifth American to be elected an honorary fellow of the Royal Aeronautical Society

SAE Past-President **EDWARD WARNER,** member of the Civil Aeronautics Board, has been elected an Honorary Fellow of the Royal Aeronautical Society. Four other Americans – all of them members of the SAE – have previously been accorded this honor, only 17 Honorary Fellows in all having been elected in the 76 years of RAS existence. The other four Americans so honored were: **ORVILLE WRIGHT** in 1908; **DR. J. C. HUNSAKER** in 1920; **MAJOR LESTER D. GARDNER** in 1939; and **T. P. WRIGHT** in 1941. Mr. Warner recently delivered a lecture on "Post-War Transport Aircraft" before the Royal Aeronautical Society in London.

JAMES W. REETZ, formerly a student at the Curtiss-Wright Technical Institute, recently joined the Vega Aircraft Corp., Burbank, Calif., as draftsman.

Formerly designing engineer in charge of product illustration, Stinson Aircraft Division, Consolidated Vultee Aircraft Corp., Wayne, Mich., **ARTHUR M. FITZPATRICK** is now connected with John Tjaarda & Associates, Detroit. This company is engaged in research and experimental designing and engineering on aeronautical, automotive and industrial products.

WILLIAM T. DRURY, JR., is a first lieutenant in the U. S. Army Air Forces, Headquarters Air Service Command, P. O. 406, Patterson Field, Fairfield, Ohio. Lt. Drury had been chief automotive adviser to the assistant chief of staff, G-4, U. S. Army, Headquarters Armored Force, Fort Knox, Ky.

HOMER W. CLAPPER is a service engineer at Wright Aeronautical Corp., Paterson, N. J. Mr. Clapper had been supervisor of service activities, Wright Aeronautical Corp., Lockland, Ohio.

COM. LEWIS K. MARSHALL, USNR, was recently promoted from lieutenant commander. Com. Marshall is in the Manufacturing Operations Group, Navy Bureau of Aeronautics, Washington.

Promotion of **CLARENCE L. FOUSHEE, JR.,** from assistant foreman to foreman of the Manifold Experimental Department, Ryan Aeronautical Co., San Diego, Calif., recently took place.

ROBERT E. WILSON, industrial chemist of New York, spoke at the 122nd commencement exercises of Colby College, Waterville, Me. Dr. Wilson is president of the Pan-American Petroleum and Transport Co.

E. C. HOKANSON is senior maintenance engineer in the Aviation Division of the Whiting Corp., Harvey, Ill. Formerly Mr. Hokanson was manager of the West Coast Branch of the company, with headquarters in Los Angeles.

S. T. ROBINSON is manager of the Sales Research Division, Wright Aeronautical Corp., Paterson, N. J. He was formerly a sales engineer for the same company.

LT. ORVILLE L. ADAMS, USNR, is engaged in supervising the maintenance, repair and operation of diesel-powered ships. He is on the staff of a Naval Operating Base, and is stationed at a U. S. submarine base.

Lt. Orville L. Adams

WILLIAM F. BAUGHMAN is employed by the U. S. Navy as an automotive mechanic under the Civil Service Employment Bureau. Formerly in charge of motor vehicle maintenance, Lake Shore Gas Co., Ashtabula, Ohio, Mr. Baughman can now be reached at Sub Base No. 128, P. O., San Francisco, Calif.

CAPT. DONALD B. ROBERTS, U. S. Army Air Forces, is commander of the 43rd Depot Sup. Squadron, Air Depot Training Station, Albuquerque, N. M.

JOHN EDWARD POWK, formerly a flight instructor, Richmond Air Transport & Sales Service, Richmond, Va., has joined Transcontinental & Western Air, Inc., Intercontinental Division, Washington National Airport, Washington, D. C., as second flight officer.

Formerly a development engineer, **WILBUR F. SHURTS** has now become chief engineer of the Hydraulic Division, Twin Disc Clutch Co., Rockford, Ill.

LT.-COM. P. H. GROULEFF can be reached at the U. S. Submarine Base, New London, Conn.

Formerly commander of the Royal Engineers, Belfast, Ireland, **LT.-COL. W. SMITH ROLLO,** British Army Staff, is stationed in Washington.

MOORE KELLY, JR., has been promoted to corporal and transferred from the Quartermasters Supply Department at Camp Young, Calif., to the Army Air Corps Headquarters Squadron, Materiel Command, Wright Field, Dayton, Ohio. He has been assigned to the experimental engineering laboratory at Wright Field.

Formerly layout draftsman, Cleveland Diesel Engine Division, General Motors Corp., **FREDERICK L. BRASH** is now in the 361st Engineers Regiment, Company C, Camp Claiborne, La.

ROLAND H. WOLCOTT has been made assistant group leader of materials engineering, Consolidated Vultee Aircraft Corp., New Orleans Division. He had been ma-

terials engineer in the San Diego (Calif.) plant of the company.

General Motors announces the election of **L. C. GOAD** to vice-president of the corporation. Mr. Goad is general manager of the Eastern Aircraft Division of General Motors Corp., Linden, N. J. He has played

L. C. Goad

an important part in the construction of seven major GM plants, including the Delco battery plant in Muncie, one of the largest of its kind in the world. In 1940 AC's spark plug plant was constructed largely under his direction.

Formerly field engineer, Wright Aeronautical Corp., Paterson, N. J., **E. A. BONIFACE, JR.,** is now project engineer at American Airlines, Inc., La Guardia Airport, New York.

ARTHUR H. HERTS is no longer production officer for British Ministry of Supply, New York City, having left this position to join Automatic Production Tool Engineers, Inc., Chicago, as general manager.

Transfer of **CLYDE HAYNES** from Fort Breckenridge, Ky., to Fort Huachuca, Ariz., recently took place. Mr. Haynes is principal automotive adviser, 370th Infantry.

LT. (jg) AMELIUS B. SEGALL, USNR, is on duty at the Submarine Repair Unit, San Diego, Calif., as assistant to the machine shop superintendent. Lt. Segall was a research engineer in private life, with the Detroit Aluminum & Brass Corp., Detroit.

EDWIN WINKLER, who had been a junior design engineer, Douglas Aircraft, Inc., El Segundo, Calif., has been aeronautical design engineer for the same company, and is now located in Tulsa, Okla.

T. T. CORRELL, Pacific Motor Trucking Co., Los Angeles, has been promoted from assistant superintendent of shop to superintendent of shop.

Formerly vice-president in charge of engineering, Strickland Aircraft Co., Topeka, Kan., **LEONARD TROY** is now aeronautical engineer at the Spartan Aircraft Co., Tulsa, Okla.

GEORGE A. ZINK is no longer with the Allison Division of the General Motors Corp., Indianapolis, where he was an engineer. He left this position to become works manager of General Motors' Detroit Diesel Engine Division.

LELAND R. YAGER, USNR, is an aviation cadet. Formerly he was an engineer for Pan-American-Grace Airways, Inc., Lima, Peru.

Promotion of **ARTHUR C. BLOOMER** from junior engineer, Product Department, Continental Motors Corp., Garland, Tex., to experimental tool engineer for the same company, recently took place.

Four SAE student members received awards in the Undergraduate Award and Scholarship Program of The James F. Lincoln Arc Welding Foundation, Cleveland. They are **JACK R. DOUGLASS, HAROLD BOEPPLE** (a co-author), **J. E. FRICK,** and **ROBERT F. BRADLEY,** all of Oklahoma A and M College. The object of this project was "to encourage engineering students to study arc welded construction so that their imagination, ability and vision may be given opportunity to extend knowledge of this method and thus aid the war effort and economic reconstruction in the peace which is to follow."

HERBERT I. SULLIVAN was recently appointed vice-president of plant and equipment, Eastern Massachusetts Street Railway. Mr. Sullivan has been connected with the company for the past 37 years, and since 1934 has been superintendent of rolling stock and shops, with offices at Campello and Boston. He is also consultant on military personnel in the automotive field for the U. S. Army.

LOUIS BARRESE has joined the Rochester Magneto & Starter Service as a mechanic. He formerly was fleet operator for the Rochester Packing Co.

Childress Buckner Gwyn, Jr.

CHILDRESS BUCKNER GWYN, JR., for the past eight years chief engineer of the Fansteel Metallurgical Corp., Chicago, and a member of the SAE since 1930, is now chief engineer and general manager of the Chicago Division, Allied Control Co., Inc.

SAE student members now engaged in war work include **GILBERT FRITZ CARLSON,** graduate of Purdue University, now a test engineer at the Dodge Chicago plant of the Chrysler Corp.; **J. H. VAN MOSS, JR.,** formerly Curtiss-Wright Technical Institute, now a planner in the detail parts planning department of the Douglas Aircraft Co., Chicago; **EUGENE WILLIAM PLACE,** Massachusetts Institute of Technology, now with Brewster Aeronautical Corp., Johnsville, Pa.; **LEONARD MEYERHOFF,** graduate of New York University, now junior engineer, Curtiss-Wright Corp., Propeller Division, Caldwell, N. J.

CLARENCE W. HACKNEY, Wright Aeronautical Corp., Paterson, N. J., has been promoted from junior experimental test engineer to senior test engineer.

RALPH S. WHITE, on overseas duty with the U. S. Army Air Forces, has been promoted from major to lieutenant colonel.

DWIGHT AUSTIN recently resigned from the position of new development engineer with the Yellow Truck & Coach Co., Pontiac, Mich., to organize a new company,

Dwight Austin

Dwight Austin & Associates, consulting engineers, with headquarters in Kent, Ohio.

E. GRINHAM, who had been general product manager, De Havilland Aircraft Co., Ltd., Herts, England, has transferred his activities to Humber, Ltd., Coventry, England.

ENSIGN S. E. ELLERBE, USNR, recently accepted a commission in the Naval Reserves and has been assigned to the Naval Aircraft Factory at Philadelphia as assistant plant superintendent in charge of transportation.

CHARLES F. BRADSHAW is now in the U. S. Army. Before entering service Mr. Bradshaw was liaison engineer, Owosso (Mich.) Division, Bendix Aviation Corp.

F. W. SMITH was recently made New England sales manager of the D. A. Stuart Oil Co., with headquarters in Boston, Mass. He was formerly in the lubrication department of the Cities Service Oil Co. of Pa., New York City.

Formerly a member of the engineering staff of Aircraft Hydraulic Supplies, Ltd., Windsor, Ont., Canada, **WALTER G. CHANDLER** was recently promoted to the position of production engineer.

CAPT. JACK M. RADKEY is company commander, in charge of maintenance, 563rd Engineer Boat Maintenance Battalion, Third Engineer Amphibian Brigade, Fort Ord, Calif.

R. C. HANSCOM, formerly an instructor at the Curtiss-Wright Technical Institute, Glendale, Calif., is now instructing for the War Department, San Bernardino (Calif.) Army Air Depot.

Formerly arc and gas welder for the Ward Furniture Co., Aviation Division, Fort Smith, Ark., **ROY C. WALLACE, JR.,** is now with the Fairchild Aircraft Co. of Burlington, N. C., as combination welder.

ENSIGN JOHN C. ESTABROOKE, USNR, formerly automotive technician, U. S. Army Quartermaster Corps, Holabird Motor Base, Baltimore, Md., has been assigned to active duty.

B. C. HEACOCK of Peoria has resigned his position of director of the distribution bureau, War Production Board, and returned to his post as chairman of the board of the Caterpillar Tractor Co.

WILLIAM E. SCHAEFER, who had been a draftsman at the General Machinery Corp., Hamilton, Ohio, has been appointed an ensign, E-V (S), USNR, and expects to report for duty shortly.

Formerly service manager for Murphy Motors, Ltd., Honolulu, Hawaii, **DAVID J. WHITSON** is now employed by the U. S. Army, Hawaiian Department, as automotive adviser at Fort Shafter, Hawaii.

RICHARD K. SNIVELY, industrial engineer for magnesium production, Aluminum-Magnesium Division of Revere Copper & Brass, Inc., has been transferred from New York City to Baltimore.

Formerly research engineer, Standard Oil Co. (Ind.) Engine Laboratory, Whiting, Ind., **EDWIN A. DROEGEMUELLER** is now assistant project engineer for Pratt & Whitney Aircraft, East Hartford, Conn.

Formerly chief of the Motors Section, U. S. Army Quartermaster Corps, Supply & Service Division, Fort Custer, Mich., **CAPT. DAVID M. DEAN** is now custodial officer, Supply and Service Division, Camp Ellis, Ill.

R. T. LONG has received a commission in the U. S. Army as major, Ordnance Department. He is temporarily assigned with the 46th Infantry Division, Automotive Section, Fort George G. Meade, Md.

THOMAS D. KING has been promoted from ensign to lieutenant (jg), and can be reached in care of the Fleet Postmaster, San Francisco, Calif. He was formerly stationed at the Kaneohe Naval Air Station, Oahu, Hawaii.

Formerly at a submarine base in Pearl Harbor, Hawaii, **LT. W. J. DANN,** USNR, can now be reached through the Fleet Post Office, San Francisco.

LT. LEE G. SNYDER, USNR, has been transferred from radio, electrical and radar officer, Office of Inspector of Naval Aircraft, Douglas Aircraft Co., Inc., El Segundo, Calif., to the Office of General Inspector of Naval Aircraft, Western District, Los Angeles.

LT.-COM. D. B. PEYTON, who had been in the assembly and repair department, Naval Air Station, Pearl Harbor, Hawaii, can be reached through the Fleet Post Office, San Francisco, Calif.

Acceptances of life membership in Automobile Old Timers, Inc., at a recent meeting held in New York City, included the following SAE members: **LT.-GEN. WILLIAM S. KNUDSEN,** War Department, formerly president of General Motors; **E. P. duPONT,** president, Indian Motorcycle Co.; **JOSEPH W. FRAZER,** president and general manager of Willys-Overland Motors, Inc.; **SAE PAST-PRESIDENT A. W. HERRINGTON,** chairman, Marmon-Herrington Co.; **C. I. OCHS,** president, Eaton Mfg. Co.; **H. L. WECKLER,** vice-president, general manager and director, Chrysler Corp., and president of Dodge Bros. Corp.; and **F. C. CRAWFORD,** president, Thompson Products, Inc.

SAE student members who recently entered military service include: **JOHN J. GOODILL,** formerly University of Detroit, now an air cadet candidate stationed at Erskine College, S. C.; **DAVID S. KAUFFMAN,** formerly Texas A & M College, now in the U. S. Army; **WILLIAM McNAIR, JR.,** Texas A & M College, now at Officers Candidate School, Aberdeen, Md.: **ARTHUR E. WITZKE,** formerly Lawrence Institute of Technology, now in the U. S. Army; **NORMAN E. FINCK,** formerly Texas A & M College, U. S. Army; **JOHN N. GROMER,** University of Colorado, U. S. Army, Battery D, 14th Battalion, Fort Bragg, N. C.; **JOHN A. CLARK,** Lawrence Institute of Technology, U. S. Army Air Forces, Jefferson Barracks, Mo.

SHERMAN VANNAH has joined the Lawrance Engineering & Research Corp., Linden, N. J. Formerly Mr. Vannah was a teaching fellow at the Engineering School, Harvard University, Cambridge, Mass.

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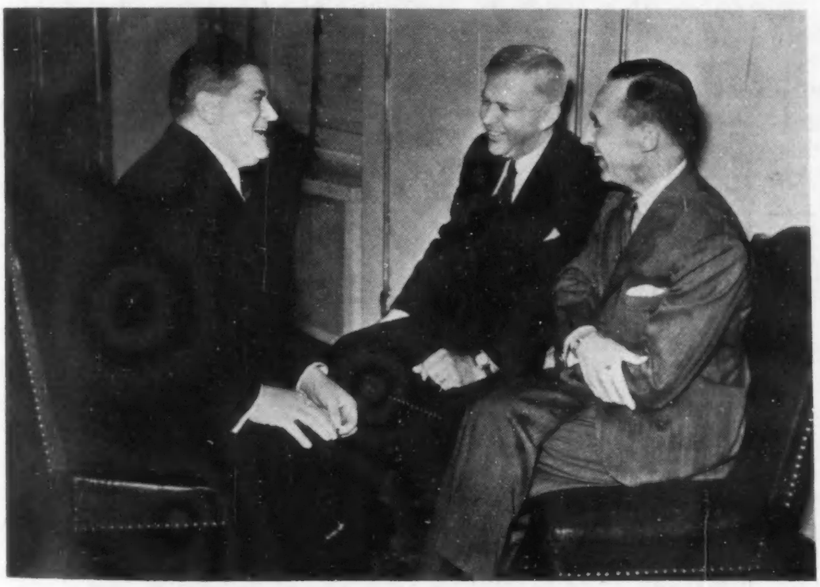

Edsel

Bryant

Ford

EDSEL B. FORD died on May 26, 1943, following an illness of some weeks. This picture, taken at a Detroit Section SAE meeting late in January, is one of Mr. Ford's most recent photographs. He is chatting with K. T. Keller and C. E. Wilson. A member of the SAE since 1925, Mr. Ford was active in support of the Society's aims and activities.

Funeral services for Mr. Ford, held May 28 at Christ Church Chapel, Detroit, were attended by SAE Past-Presidents Ralph R. Teetor and A. W. Herrington and by SAE Secretary and General Manager John A. C. Warner, as representatives of the Society's Council.

Torture-Testing War Equipment

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Ground; Camp Seeley Desert Training Center, California; Milford (General Motors) Proving Ground; Ordnance Winter Detachment, Camp Shilo, Manitoba; other Army training camps, other automotive and industrial proving grounds and test laboratories;

Supervising research activities in the conservation of critical materials, and the introduction of new and substitute materials;

Maintaining liaison and coordinating our research developments with those of other units of the War Department, the Navy, other Government agencies, industry, and engineering organizations;

Obtaining and analyzing technical information and weapons from foreign countries, including captured weapons, ammunition, and other fighting equipment;

Approving specifications for the Chief of Ordnance;

Considering submitted inventions;

Investigating cases of defective functioning of standard Ordnance equipment where military characteristics are affected;

Considering design changes suggested in field reports from camps and battlefronts throughout the world.

Our Aberdeen Proving Ground, established in 1918, is essentially a laboratory. It consists of 43,000 acres, and contains some of the finest test equipment in the world. Major-Gen. Charles T. Harris is in command. Its Chief Proof Officer is Col. George G. Eddy, with Lt.-Col. A. Schomberg as his executive officer. Its main subsidiaries are:

Arms and Ammunition Division, in charge of Lt.-Col. J. W. Cave;

Automotive Division, under the direction of SAE Member Col. W. B. Johnson;

Ballistic Research Division headed by Col. L. E. Simon;

Field Service Division in charge of Col. A. B. Roberts.

Among the important engineering branches are the Foreign Materiel Branch under Lt.-Col. J. B. Jarret, and the Armor Plate Branch under Major G. E. Philipsen.

Here at Aberdeen all tests are made under carefully controlled conditions. Check tests are made of production items from time to time. Special measuring devices have been developed and built to test velocities of projectiles, pressures in the gun, recoil velocities, time of flight of antiaircraft shell, the coordination of the point of burst, and other characteristics of guns, ammunition, and other equipment.

The Aberdeen automotive laboratory tests pilot and experimental (T) models of all automotive equipment and other wheeled or track-laying equipment, as well as standard production (M) models. Special dynamometers have been developed and built at Aberdeen to test suspension, track, wheels, power train and engines and their accessories. We have developed equipment to measure rolling resistances of all types of vehicles. Research in armor plate and rubber are two important tasks of the Automotive Division. Use of radial aircooled engines and the use of rubber for tracks of high-speed track-layers were more recent developments there. What is believed to be the largest dynamometer in this country is there, and a larger one is being completed. Permission has been granted to industrial concerns to use these facilities.

Army Ordnance Arsenals

THE six Army Ordnance Arsenals are the nucleus of the vast laboratory facilities used by the Ordnance to develop, test, and manufacture weapons for our armies. They represent an investment of approximately $545,000,000, and employ about 80,000 military and civilian personnel:

Springfield Arsenal, Springfield, Mass., 1777;

Watervliet Arsenal, between Albany and Troy, N. Y., 1813;

Frankford Arsenal, Philadelphia, 1815;

Watertown Arsenal, Watertown, Mass., 1816;

Rock Island Arsenal, on an island in the Mississippi River near Davenport, Ia., and Rock Island, Ill., 1862; and

Picatinny Arsenal, 1892, built on the site of the Picatinny Powder Depot, near Dover, N. J., which was begun in 1879.

Five Major Steps

From inception to production, Army automotive equipment and other Ordnance products go through these steps:

1. A new item may be originated by an individual officer or a project staff of the Ordnance Department, or by someone in one of the Army's arms or services. Occasionally, as in the case of the Garand rifle or the jeep, it is submitted to the Army Ordnance Department by an individual inventor or a company. The new folding, hard-hitting submachine gun M-3, recently announced, was the idea of and developed by Col. Rene R. Studler, chief of our Small Arms Development Branch, whom I consider to be the nation's outstanding engineer in this field.

2. After a study by the Ordnance staff specializing in a particular field, the item is referred to the proper Technical Subcommittee of the Ordnance Technical Committee.

3. If the project is approved, the Ordnance Department negotiates with a manufacturer for experimental models, or directs one of its arsenals to produce them. Upon completion of the experimental (T) models, the Ordnance Department conducts performance tests, sometimes combined with service tests at the Proving Ground. If simultaneous Ordnance and service tests are not feasible, the pilot is sent to the appropriate Service Board for testing.

4. All test results are correlated by the Ordnance Department, which directs changes to be made in design to meet whatever recommendations are approved by the Secretary of War. The pilot has been carefully checked to apply the utmost standardization of parts, and to improve maintenance.

5. Upon approval for standardization by the Ordnance Technical Committee, the Army Ground Forces and/or the Army Air Forces direct the Ordnance Department to have a specified number built. They are delivered to the designated Ordnance Depots for storage and distribution to training camps and battlefronts.

Ordnance Field Service

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depot there are 40 square miles of land and some 50 miles of railroad trackage. In all our Ordnance Field Service depots, there are some 2000 miles of hard-surface roads for truck operations and nearly as much railway line as is owned by the Baltimore and Ohio.

Some of these Ordnance depots are in very picturesque locations. One of them in the Southwest is in the heart of the Indian country, and most of the labor is Navajo. In order to encourage the Indians to work at this depot, the Government has established a housing project consisting of hogans.

As we approach the entrance of this depot, a large transport plane flies overhead. Two Indian children look up.

"Nabishnatai!"

"Nachittanatai!"

"Automotive that flies!" says one.

"Big noise that flies!" says the other.

In the operation of its far-flung depot system, Field Service is acutely conscious of the necessity for conserving manpower. In this connection, it is significant to point out that from August, 1942, to April, 1943, the tonnage volume in and out of Field Service depots showed an increase of 150%, while during the same period the employees in the depots increased only 85%. If, through increased efficiency of operation, each of our employees handles one more 80-lb unit per hr, our workers will handle one day's supply for an additional 750,000 troops. In connection with the saving of manpower, the greatest possible emphasis has been placed on the employment of women for all types of work. Experience has demonstrated that there is comparatively little difference in industrial employment between men and women, and in some positions women are definitely superior. For example, in the warehouses, the housekeeping instinct of the women shows up to great advantage, and warehouses are neater and in better order where a large percentage of women are employed.

The other day in one of our depots a little woman in blue jeans was seen aloft in the control cab of a giant crane. She was swinging 30 tons of anti-aircraft gun easily down the shop and gentling it into its anchorage as delicately as she might ease a baby into his cradle. Her strength was multiplied – how much? Perhaps 1,000,000 times. And it was said that her touch on the crane controls had been found more precise than a man's.

Field Service now employs approximately 40% women, and the goal is to employ at least 60%.

■ Shipping Cubage Reduced

A statement was printed recently to the effect that this country is building five ships a day. There might have been added a sixth and then some over, for Ordnance Field Service depots are building ships too. They can't be counted because they are built a little at a time. They are built of pine boards and 10-penny nails, of horse sense, and engineering science. They are built by reducing the shipping cubage of our weapons.

For example, Field Service packaging engineers have found a way to ship 0.50 caliber heavy barrel machine guns in less than one-third the space formerly required; the caliber 0.30 Garand, with a reduction of 20% of cubic requirements; motorcycles with a saving of one-third; 90 mm anti-aircraft guns are now being packed in 300 cu ft less space with a saving for each gun of 20%. Medium-size tractors have been repacked to save 190 cu ft of space for each machine, or about two-fifths, while a generator, widely used as a source of electrical supply for artillery and shops, is packed to save 43½% of space. These are a few out of hundreds of savings. The results are accomplished by rearrangement of items in the box, by various partial disassemblies, by improved nesting, and by all the other devices familiar to commercial practice.

There is this difference: our disassemblies are limited by the ability to reassemble in the theaters of operation, and in some cases by the requirement that weapons and vehicles be able to go into action immediately upon landing.

■ Preparation for Shipping

Ordnance has three tank depots in which products are stored and prepared for overseas shipment. Vehicles arrive at these depots in various stages of completion. Often only part of their normal tools and equipment accompanies them. A call comes in for a certain number of vehicles for a specific area, or, under our Lend-Lease agreement, for a particular ally. From the storage yards they come, carefully inspected, modifications made. On a production line basis they get every item necessary to do their job and then are processed for the long ocean voyage against the elements of salt air and salt water. When they arrive at their destination, they are ready for action within a few hours.

The civilian driver who fails to recognize the importance of preventive maintenance suffers comparatively little. It may mean at the worst a walk to the nearest telephone or gasoline station. But to the soldier on the battlefield a breakdown of his equipment may mean death. It is sad to be forced to admit that from a failure to recognize this fact in the beginning, far too many crosses now dot the desert. Our soldiers have had this lesson driven home to them so that they will have a better chance of coming home to us. They have been trained in their servicing and their maintenance. They know that one loose wire, one faulty spark plug, one speck of dirt in the feed line can put the best tank or the best airplane out of action. Fighting weapons today must be serviced continually. Adequately serviced, they will perform wonders, but woe unto the soldier and the unlucky ones, his comrades, if for one moment he relaxes his vigilance.

Odd climatic conditions in foreign countries create new problems that must be met if disaster is to be avoided. A lethal consequence resulted for one tank crew in Africa who failed to take into consideration the inordinate night dew. Leaving a gasoline filling can uncovered overnight, they failed to note that there was a considerable amount of water condensation in it. The tank failed in action, and the crew did not return – surely a fearful price for this bit of thoughtlessness. Another crew of fighting men forgot to cover their grease cans against the blowing sands of the Sahara. Bearing failures from sand infiltration left them stranded, and a happy fighting crew is now represented by a group of crosses.

Forgetting the simple routine of turning an engine over to check against hydrostatic lock cost a tank driver and his pals their lives in the desert.

Another crew religiously made the 100-hr check on their engine shortly before a tactical operation began, but failed to cover the air intake pipe and open air lines when they checked the engine. The sand did the rest.

One more case comes to mind. A one-tank patrol was lost because the men sat in position and played their radio unnecessarily. When scheduled to advance, they had insufficient power to start the engine.

■ Care Gives Excellent Results

These failures, of course, are very impressive, but as usual the failures are few in comparison with the excellent results of proper care and thoughtfulness. Take the case of a unit on the North African battlefield who took exemplary care of their vehicles. They drove them 400 miles past the shadow of the Pyramids and the Sphinx; then the vehicles went forward by rail and again moved 70 miles further. Carefully servicing their tanks, the unit drove forward another 74 miles and made contact with the enemy, and the entire group, consisting of 166 vehicles, went into the assault operating perfectly.

This same organization went through 32 days of continuous combat and in all this time had only 12 minor mechanical failures, which were quickly corrected so that the vehicles were returned to combat immediately. It is known that this group of tanks saved the day. Not only did the vehicles respond to attention, but because they did respond the men gained confidence, and as a result were more daring and aggressive fighters.

Because this is a global war and is fought in every type of climate, it is up to us in the Ordnance Department to find out all of the odd climatic conditions that may cause our soldiers trouble, and to guard against them either by proper mechanical construction or by advance training of our soldiers in overcoming these conditions. It is for this reason that we have the Desert Training Center at Indio, Calif., where temperatures range to 130 F in the shade outside the vehicles and to an unbelievable figure inside the closed tanks, where one cannot touch any metal without wearing gloves to prevent the hands from being blistered; where blowing sand destroys in a few hours any vehicle the engine of which is not adequately protected with highly efficient air cleaners. It may be of interest to know that some foreign tanks we have obtained were put out of action by running about 15 min in this desert location, because of inefficiency of the air cleaners with which they were fitted. We do not intend our soldiers to suffer from the same lack of mechanical precautions.

■ Winter Proving Ground

The opposite extreme is the winter proving ground located in the far North to determine and overcome problems such as those met on the Alcan Highway, where trucks being towed from the unloading point simply skidded. The wheels refused to turn because the grease in the bearings was frozen solid.

In this winter proving ground, where temperatures of 40 to 60 F below zero are encountered for days on end, strange things were discovered. Plastic name plates cracked and fell to powder. Plastic handles on car doors simply came off in the hand when an effort was made to open the door. Some wire was insulated with a plastic compound; at the first vibration, all insulation fell off the wires, leaving them bare. There are many different types of synthetic rubber and rubber substitutes. Some of these behaved admirably in the winter climate, but there was one type of synthetic rubber which became as brittle as glass in the low temperature, and tires which were dropped or subjected to driving shocks shattered like a pile of old phonograph records. With a perfectly free bearing and brake, this same tire had so little traction that instead of turning the wheel it just slid across the icy roads.

There were very encouraging things discovered there too. One was the fact that ammunition left in that extreme temperature for days functioned perfectly.

Another aspect of this global war is the manner in which the American motor vehicle has penetrated the furthest frontiers of civilization, and even beyond. The common denominator of all continents and climates today is the military motor vehicle of American design and build. Our soldiers are driving American tanks and trucks over camel trails and reindeer tracks and kangaroo runs and water ox paths and crocodile slides, and into country and through country where camels or reindeer or crocodiles would turn around and go home. Vehicles and roads used to grow up together; now the Army asks only if there is traction or leverage – and if there is we go in and fight.

■ Maintenance Manuals

And wherever we go we carry the civilizing influence of our maintenance manuals, translated into all languages, as varied as the terrain. We are sending to the mighty armies of the United Nations our tanks and trucks, which speak an international language; and our manuals, translated into their separate tongues. We are placing our vehicles and methods in the hands of bushmen and Frenchmen, men of swamp and jungle and ice and sand, camel-drivers and fiat tourists, and the men of the entire United Nations' world are learning American lessons they will not forget. Our vehicles are going ahead of the flag, to paraphrase an old imperial slogan, and this time they are carrying freedom.

The vital part that the automotive industry is playing in the war is well illustrated by two facts: First, the fact that two-thirds of the daily sustaining tonnage necessary to supply a fighting force is made up of petroleum products, and only one-third of ammunition, food, and daily general supplies. This is a graphic index of the extent to which the modernization of the Army has progressed since the last war, when the bulk of supplies consisted of ammunition first, and forage for our horse-drawn vehicles next.

The second outstanding fact emphasizing the importance of automotive engineers in this war is the hard fact that 85% of the installed horsepower in the entire United States is in automotive equipment. All of the power installed to operate our factories, to light our homes, and to run our railroads, and to do all of the many other things that require mechanical effort, represents less than 15% of the nation's total.

Of the 1,670,000,000 hp installed in America, including that within the sinews of the hay-burning horses and mules on our farms and the oil-burning locomotives on our railroads, 1,424,000,000 is in our motor vehicles.

Can you wonder that we consider the Society of Automotive Engineers of the utmost importance to the War Effort?

Designing for Accessibility

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invite neglect or insufficient and even incorrect lubrication, a postponement, or improper adjustment, and all this despite preparation of the most complete lubrication charts and adjustment instructions imaginable.

Another angle in the military pattern which is not as critical in the commercial picture is the use of a procedure which we call "cannibalization" for lack of a better term. Spare parts and unit mortality in military service follows no fixed or predictable cycle, and the supply system, especially in overseas theaters, will always be strained to the limit. The ability to make one serviceable vehicle out of two, three, or even a half-dozen cripples may give the theater commander just that narrow margin of superiority which he needs to win his objective. You who have read of the feats performed in this respect by the gallant defenders of Wake Island, Major Devereaux and his hard-bitten Marines and airmen, can appreciate the importance of designing for easy "cannibalization."

Commercial operating units, due to the competitive factors involved, must pay attention to details of eye-appeal and style, protection of load, comfort of driver, and many other factors which do not apply to the military use of mechanized equipment. The military equipment is, and must be, to the maximum, essentially functional in all respects. The best examples of this principle are our tanks and combat vehicles, which have been designed and developed for the single purpose of battle efficiency. Had our national military policy been somewhat different during the interim between World War I and the period of Army expansion just previous to Pearl Harbor – those years of peace which George Washington in his wisdom cautioned should be used to prepare for war – it is possible that our present motor transport vehicles might have been more functional and even more homely than they are. I think the differences would not have affected the production picture in the least. As matters stand, however, our procurement policy since 1933 has been based on the principle of using commercially produced vehicle designs with the minimum modifications required to meet specific military purposes. Consequently, the problem of improving the accessibility of parts in our military vehicles was not as simple as it might have been. Thanks, however, to the ever-willing cooperation of the truck industry as a whole, and particularly its engineers in the SAE, many gratifying results in this respect have been attained without major changes in the essential design of units or their production processes. Further modifications are being made, and all with a minimum of interference in the swift and steady flow of production so vital to the success of our war effort.

It is not the purpose of this paper to reflect upon the

The amphibian, above, nicknamed the "duck" by troops, is an unhappy example of inaccessibility although it has proved its value in combat

Trucks used in World War I left much to be desired in so far as transportation was concerned, but were more accessible for repair and maintenance than newer vehicles

merit of commercial products, as manufactured for commercial use, from the standpoint of accessibility or any other particular feature. In general, all commercial designs have their good points and also their respective questionable details. This is really a good condition, and is the basis of free enterprise and competition, without which, advancement in technique and processes – resulting in improved vehicles at lower price levels than would otherwise be possible – would have been unattainable.

There are other changes in design practices which directly affect accessibility. Many of these may be classified as luxury refinements and "gadgetry," and have no relationship to the functional characteristics which are of prime interest to the military services.

Advanced design has resulted in more compact vehicles, mounted on tires which, a quarter of a century ago, would have immediately brought forth the laughs enjoyed by Andy Gump's famous doughnut tires; prophetic they were. Of course, we can crowd more COE trucks, with many times the cargo capacity, onto a city-block-wide road than could ever have been possible with the primitive equipment of those days; and in our modern high-speed manner of life we must do just this in order to keep the supply in pace with the demand. But I ask you, how many of our modern COE designs have been laid out on the boards with a care to making it easy for Joe Doaks to change the spark plugs in the rear cylinders, or even to check the crankcase oil level, without learning to become a candidate for Vargoni's troupe of contortionists? How many of you who are supervising engineers require the designing crew who make decisions over the drawing board actually to perform servicing operations on the resultant physical translation in iron and steel?

I admit that the modern commercial vehicle is an efficient, comparatively long-lived mechanism, which requires much less attention, lubrication, and adjustment than the behemoths which alternately roared and staggered about the highways a few years ago. But let us examine the results from the viewpoint of commercial mechanic Jones.

■ Jones and His Equipment

When Jones is assigned the job of adjusting the "ring that holds the thing that oils the thingamajig" he needs a bushel basket of special tools plus a can opener and a divining rod to get at the part, and when he finally has cleared the way, the adjustment, to be made properly and according to the manufacturer's instruction book, requires the use of a transit and level, a stroboscope, and a three-step thickness gage. In some cases a surgeon's procedure in an appendectomy is no more complicated, even to the closure of the incision, except that our friend Jones needs more than an amateur's skill as a sheet metal welder in lieu of skill in the manipulation of catgut sutures. Fortunately for Jones, he works for an employer who has provided all the necessary special tools and aids required for completely servicing the particular models of trucks which he operates, and has built a comfortable, dry, repair shop for Jones to work in. If Jones happens to drop some of the excavated parts removed during his quest, they probably won't roll much beyond the truck in the next stall.

Let us now observe Pfc. Smith, Umpty-Umpth Ordnance Battalion, Medium Maintenance, in bivouac on a side road behind the Steenth Division which is battering its way to Berlin. He is assigned the same job as Jones, but his shop is a muddy copse among the blackthorns. He does not have access to a completely stocked tool room. For economy's sake, so that more trucks can be available to haul "chow" and ammunition to the front line troops, the Battalion's tool equipment has been pared to the bone – and we have found just this to be necessary. If Smith happens to drop a part or a tool during the job, it probably will disappear in the gumbo ooze which seems to be one of war's universal conditions. I submit to you the query, "What would you do?" and I believe you will agree that Pfc. Smith's profanity is entirely justified.

■ COE Accessibility Is Poor

I mentioned COE designs as being, in my opinion, especially bad offenders against the cause of accessibility. Many of the points of inaccessibility which have been disclosed arise from the process by which the vehicles are designed and built. The engine designer may have been exceedingly diligent with respect to the accessibility of parts so far as the engine alone is concerned, and it is probable that, mounted in a stand, its parts and adjustment points are quite easy to get at. When installed in a chassis, however, unforeseen interference with other chassis units or parts may occur, which in some cases may make even the simplest repair or adjustment operation all but impossible without removing the engine from the chassis. While this may be a comparatively simple operation in itself, complications often arise in accomplishing it after the cab, radiator, and fenders have been assembled to the bare chassis. To get at the engine or for unit replacement, the reverse of the assembly process may be required. We have seen one case in which the simple replacement of the fan belt has necessitated a half-hour's wastage of labor in disassembly and reassembly, and another in which the steering gear could not be removed unless the engine was first removed.

I will cite some examples of conditions we have discovered which called for corrective action. One involved the transfer case of one of our larger trucks. A bolted support was used so that mounting brackets were permanently attached to the frame and the transverse supporting members, riveted to the transfer case, were bolted thereto. In a stripped chassis, the unit could be readily removed or replaced, but when the cab and body were installed, these bolted connections were no longer accessible. Removal required that the rivets be burned out and replacement required re-riveting or reaming of the holes and the substitution of bolts. Revision of the design now provides bolts in the original assembly.

Some of these situations are the results of slight oversights, others plain, undiluted blunders. The majority of them either have been or are in the process of being corrected.

It should be appreciated that tank design sometimes must submerge the consideration of ideal accessibility to that of ammunition storage, fuel capacity, gun position, low silhouette, and so on, but every time this is permitted we run into the trouble of neglect, mentioned before. For the cubage involved, the interior of a tank is more congested with machinery, equipment, and battle supplies than anything else I can recall except a submarine. Even at our present stage of development, rapid and thorough inspection and lubrication of some models require the

services of a superman contortionist, adept in sleight-of-hand and acrobatics, for their accomplishment.

Items of light maintenance, such as the replacement of oil filter cartridges, have required considerable corrective action in order to reduce the time consumed in such a simple operation. Service adjustment of electrical accessories has been made easier in a number of cases by relocation, in both tanks and transport vehicles. Radio shielding has been greatly simplified and no longer requires the use of a complicated system of cable and unit armoring. The overhaul of the clutch on one early model of tank, a simple job in itself, could not be accomplished without the disassembly of the drive train and removal of the engine, and the whole operation consumed nearly three days' time. Needless to say, this has long since been corrected. In another model, a change in the oil tank design not only eliminated a lot of exposed piping, removing a potential source of damage, but also provided room in the engine compartment, facilitating routine service operations, and made the powerplant much easier to remove for heavy repair or replacement. Sheet metal shields, ducts, and so on, have been redesigned in many tank applications to permit ready removal for access to components previously quite difficult to reach. It is really remarkable that some of the engines in early tanks did not suffer from claustrophobia. Who knows but that many of the failures which were attributed to commonplace engine ailments were not in fact due to this very phobia.

The provision of hinged instead of bolted inspection covers has materially improved accessibility of our later tanks over the early production models. Quickly detachable electrical, fuel, and other connections, coupled with means for easily and quickly exposing the powerplant and train, as on a shop stand in certain of our later models, and the relocation of lubrication fittings in easily reached places, indicate the close attention which is being given by our Ordnance Department tank engineers to the problems of accessibility. The adoption of construction which permits the unit replacement of certain components almost as quickly and easily as a fuse or an incandescent lamp is a step forward and is not entirely outside the bounds of possibility for application to powerplants.

One interesting change from conventional commercial truck design practice has resulted from the battle with old man mud. In field operation over soft muddy terrain, the brake drums became clogged with mud, requiring early cleaning to prevent serious damage to the wheel brake system. The conventional design required disassembly of the hubs and exposure of wheel bearings, not only a lengthy operation but one inviting contamination of bearing surfaces. Production is now providing removable brake drums on some vehicles, making the cleaning operation almost as simple as changing a wheel. This is a compromise solution to the still controversial subject of fully enclosed versus wide open wheel brake mechanisms.

In the design of the historic Quartermaster Corps Motor Transport Service fleet of so-called "standardized vehicles," experience with which determined many of the characteristics incorporated in our current military adaptations of commercial production designs, great care was exercised to insure that all components and parts could be readily serviced. The fact was well recognized that, especially in the field, even when not under the strain of actual combat conditions, parts which were hidden or hard to get at would sooner or later be accidentally or deliberately neglected, maybe not entirely, but sufficiently to cause trouble.

Those of you who are familiar with the simple old Class B work-horse will remember that all points of lubrication, largely serviced with an oil can, were painted bright red by order, and most of them were so prominent that even hub-deep mud would not entirely hide them; neither did streamlined beauty trim.

Today, tactical motor vehicle specifications, as a result of the combined experience and records of many years past, contain such provisions as:

"Any design which renders servicing, adjustment, and replacement unduly difficult under field conditions is not acceptable."

"Crankcase oil filler shall be so constructed that oil can be poured from a one-gallon container into the filler opening without the use of a funnel and with only the hood raised."

"Crankcase oil gage finger loop shall be properly accessible."

"Auxiliary fuel filter shall be so located that it can be serviced readily by one man without requiring removal of surrounding material."

"Fuel tank fillers shall be accessibly located."

"It shall be possible to remove all wheel bearings without having to remove snap rings."

Except for the first quotation, which is intended to be all-inclusive but required specific clarification from time to time as the others indicate, each of these specification provisions was the direct result of a particular military need and indicated some distinct difference between commercial design objective and military operating conditions. The provision regarding fuel tank fillers, which, by the way, has recently been extended to require extremely large filler openings capable of receiving the contents of a standard 5-gal fuel can almost at one gulp, was introduced when it was discovered that commercial practice assumed fuel tanks would always be filled from a convenient pump nozzle at a regular filling station and were sometimes to be found hiding shyly behind a little niche in milady's fender skirts where John Soldier could not possibly feed it from the can, either with or without a nozzle. The new fillers are not bottle-fed, but can drink out of anything from the best meter pump to a nozzleless British colonial flimsy can, without slobbering.

There are two pertinent points which, in closing, I believe warrant re-emphasis.

In the last analysis, relative accessibility is measured in units of time by our troops in the field – and in the theater of operations, time is measured in flesh and blood. Thus, a physical relationship of units and assemblies such as may enable maximum, unhindered, manual adjustment on the one hand, and minimum special tool work on the other, is to be classed as nothing less than a military objective in itself.

Second, in the year and a half since Pearl Harbor, indications from the field raise a very serious question – "Have we or have we not considered accessibility, as an adjunct to military effectiveness, in its proper relation to the design picture as a whole?" Frankly, we still have a distance to go! Natural laws and physical limitations simply do not permit designers to do everything they would like to do. We all know, however, that engineering is an eternal compromise. May I propose that we compromise just a bit more in favor of accessibility?

Engines for Tanks

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acknowledged that satisfactory air cooling is more difficult to accomplish but temperature differentials are not as critical.

The third argument concerns the matter of fuel, and again stems back in part to the non-availability in the past of an entirely suitable type engine for tank use.

The fuel requirements of an engine affect what is often the weakest link in the Army supply line. The amount of fuel required has a definite influence on the amount of effort required to furnish it. The type of fuel required often has the same effect, since an engine limited to special fuels difficult to obtain in all parts of the world is dependent upon the supply line between it and the source of its particular type of fuel. Special fuels also require additional effort to be exerted on the home front due to difficulties in manufacture. Fuel requirements affect the strategical maneuverability of a vehicle and its maintenance, because of the limitations on operation from a supply point and the time involved in refueling. They often affect the layout of the entire machine, since cruising ranges, which must be met by certain sized containers of fuel, are usually established by the using arms. These in turn affect the overall size of the vehicle. The type of fuel required often determines whether the vehicle can operate under extreme ambient temperatures. The vaporization of the fuel affects operation at high temperatures by causing vapor lock, by increasing pressures on metering orifices, and by loss of fuel through evaporation. At low temperatures, failure to flow or failure to ignite causes the most difficulty. Expansion or contraction of fuel under temperature changes often makes it troublesome to provide suitable containers to control flow.

Earlier Victory Balked

The importance of having a wide enough radius of action was never more clearly apparent than on one occasion shortly after the break through of the German line at El Alamein, when Gen. Montgomery sent a mechanized pursuing force around to the German rear. Had these vehicles been capable of operating 50 additional miles, the Germans would have been bottled up and Rommel's retreat would never have taken place, and the Mediterranean would have been cleared many days ahead of time. Volume for volume, diesel fuel will carry a vehicle a greater distance than gasoline, and that coupled with the factor of reduced fire hazard for crew and vehicle sums up the relative virtues of each fuel.

Having outlined the three major factors which cause requirements for tank engines to differ from those for engines used commercially, I should like to outline to you what the Ordnance Department considers is the ideal tank engine.

The original assignment for the design of the "ideal" tank engine contemplated an aircooled low-silhouette engine capable of developing 600 net bhp (that is, exclusive of cooling fan and accessory requirements) at a rotative speed not to exceed 3000 rpm. This engine was to be reliable and simple to manufacture. If possible, its cylinder dimensions were to be such as to permit use in several sizes and geometrical shapes of engine. Development of a carburetor-type engine, using gasoline as fuel, was requested with the understanding that consideration should be given to the possibility of dieselization of the unit.

When the problem of determining whether or not a suitable aircooled engine could be built was submitted to the Special Engine Committee, the overall requirements were stated to be:

a. 650 gross hp.

b. Horizontal or V-type.

c. Aircooled.

d. Injection system capable of handling diesel fuel, gasoline, or other available fuels.

e. 1000 hr without major overhaul.

It will be noted that the fourth requirement demanded a diesel capable of using gasoline as a fuel rather than a carburetor engine. Also, during discussions, the advantages of air over liquid cooling were stressed and these were substantially as I have already given them.

The general requirements for an ideal tank engine were stated to be:

a. Reliability.

b. Adequate power for the vehicle.

c. Ease of service maintenance.

d. Long service life.

e. Reduction in the use of critical materials.

f. Low overall height.

After several months had elapsed, the Special Engine Committee recommended that: Two gasoline engines be developed: one a 450 net bhp at a governed speed of 2500 rpm and the other a 650 gross bhp at the same speed. Both of these are to be carburetor engines, as it is not thought that fuel injectors are sufficiently advanced to meet the speed variations demanded of tank engines. They further recommended that two diesel engines of the same horsepower and speed be developed. Injectors should successfully use gasoline of 80 octane rating or less, but with a lower horsepower for the same rack setting as for diesel fuel.

The engines are to be in-line Vees with an angle of 90 deg between the cylinder banks. Eight cylinders were recommended for the smaller engine and 12 for the larger. Overhead valve and camshaft construction are to be used. The oiling system is to be of the dry-sump full pressure type. Crankshaft is to be balanced in two planes and free from detrimental torsional vibrations.

Additional Requirements

In preparing requests for quotations, the following additional requirements have been added:

a. Gasoline fuel is to be 80 octane with use of 72 octane desirable.

b. Ordnance standard lubricating oils are to be used.

c. Intake charge temperature to be 130 F.

d. Engine to start on a fore and aft slope of 65 deg and right or left slope of 30 deg.

e. Cooling to be based on 150 F ambient air temperature.

f. Critical materials shall not be used when it is possible to avoid them.

Although not part of the specifications, the following characteristics are desired:

a. For the sake of manufacture and supply, side-by-side connecting rods are preferred to the fork and blade.

b. Gasoline engines should be naturally aspirated for simplicity. For torque control, the diesel may use a super-

SAE Coming Events

Aug. 19-20	SAE West Coast Transportation and Maintenance Meeting Palace Hotel – San Francisco (Auspices of four West Coast Sections.)
Sept. 23-24	SAE National Tractor Meeting Schroeder Hotel – Milwaukee
Sept. 30-Oct. 2	SAE National Aircraft Engineering and Production Meeting and Engineering Display Biltmore Hotel – Los Angeles
Nov. 4-5	SAE National Fuels and Lubricants Meeting Mayo Hotel – Tulsa
Jan. 10-14, 1944	SAE Annual Meeting and Engineering Display Book-Cadillac Hotel – Detroit

charger. This supercharger may either be a centrifugal or Roots type.

c. For ease of supply, the engine should burn any fuel from diesel oil of low cetane value to aviation gasoline of 100 octane plus. Practically, however, this probably cannot be done.

d. Cylinder design should be simple and the finning should be as rugged and easy to machine as is compatible with proper cooling.

e. Cooling fans should be designed for efficient movement of air and the airflow should be based on actual tank or mock-up data. Many factors may vitiate results obtained on the usual test stand. Either axial flow or Sirocco fans may be used. Unfortunately, large diameters usually go with high efficiency in Sirocco fans.

f. Piston speeds for diesels should not exceed 2500 fpm if antechamber design recommended by the Committee is used, since no accurate data are available for combustion at higher speeds.

g. A wet-sump engine would be desirable if it were possible to cool the oil.

h. Torsional vibration dampers may be used if absolutely necessary but add to the weight and number of parts.

Studies have indicated that a minimum cubic space is required for a given horsepower. Horizontally opposed engines gain in silhouette for engine alone, but when considering the question of cooling there is no apparent gain. These engines usually are also hard to service with respect to valves and plugs. The radial engine suffers from large diameter, which increases the height. Since the engine is almost as long as its diameter, no reduction in height is obtained by placing cylinders in a horizontal plane and using bevel gear take-off.

In addition to the requirements stated for an ideal tank engine, there is an additional requirement for a satisfactory air cleaner to accompany it. The Ordnance Department and industry both have puttered along with air cleaners for years. In spite of the fact that we do have usable engines in our tanks at present, air cleaners are still recognized as the No. 1 problem child. I am afraid the air cleaner manufacturers feel that our ideal is to get an air cleaner which will remove and automatically eject from the vehicle all of the injurious dirt from the carburetor air stream without any need whatsoever for servicing, but that is not quite the case.

Once having achieved the ideal engine, it must be protected by an adequate air cleaner and the Ordnance Department is of the opinion that it is perfectly possible to develop an air cleaner which will require service no oftener than is required for other major service, such as oil change time or engine overhaul. An oil bath type with automatically ejecting pre-cleaner now being worked on appears to have considerable promise and may be achieved prior to the ideal engine.

To summarize, we are still looking for the ideal engine for tanks. Such an engine should be aircooled, have a high enough horsepower to weight ratio to overcome the losses due to accessories and power train, should be capable of utilizing a wide range of fuels and should have an air cleaner which really cleans. There is no body of men who can contribute more in this search than the members of the SAE.

In closing, I should like to express my appreciation to Col. E. L. Cummings, Col. A. B. Domonoske, and C. E. Jacques of Tank-Automotive Center; to Capt. N. G. McLean and S. H. Woods of Aberdeen Proving Ground; and to E. E. Wilson of General Motors Proving Ground for their help in the preparation of this paper.

Comments by "Ket"

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saying we couldn't make a 7-in. engine that would run the first time we put it together. We could – but it would be an 85% engine. If you want that, I will guarantee an 85% engine right off the bat. But you cannot and I cannot predict what combination of pistons, injectors, etc., is going to be the right combination, because there are factors in there that cannot be calculated. . . .

"I can give you an engine with a factor of safety of five – which means that I am betting my figures are 20% right . . . but when you have to cut things down as we do in engines today, then you have to fight it out on the individual piece. That is all I know."

A New World

IF you can get people to take a long-range look at what can be accomplished through research and engineering – and if you can get an understanding between management and research, you can write your ticket for almost any kind of a world you would like to have, and I think you will get it.

Diesel-F&L Men Meet

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a crankcase scavenged two-stroke engine. The intake port does not open until the gas flow from the exhaust port into the pipe has been well established. Before the intake closes, the pressure in the exhaust pipe has fallen below the atmospheric level. At the time of intake port closing, the pressure in the closed end of the exhaust pipe rises to atmospheric and is still rising as the exhaust port closes, indicating that the direction of gas flow in the exhaust pipe has reversed to ram back toward the engine. The air rammed back into the cylinder is the excess that passed across the top of the cylinder into the exhaust pipe. When the exhaust pipe is properly designed, it is not necessary to use the crankcase as a means of compressing air before it is forced into the cylinder.

The expansion of the exhaust gas can be used to operate a properly timed vacuum pump and pull air across the cylinder out into the exhaust pipe and then ram it back into the cylinder before the port closes. The pressure changes can be indicated by a cathode ray.

An experimental exhaust pipe, made to slide like a trombone so that its length can be varied while the engine is running at maximum load, can be used to determine the proper length.

Exhaust Must Be Silenced

After the correct pipe has been found, it will be necessary to silence the exhaust, which is a matter of choosing a snubber having a volume about 40 times the volume of gas discharged into the exhaust with each pulse of the engine, computed on the basis of atmospheric pressure and the temperature of the exhaust gas. The snubber requires a tail pipe, the dimensions of which can be determined by test, again using the trombone idea.

The experimenter must now provide a direct means of air intake to the cylinder. Air intake silencing falls under two classifications: First, silencing of the air inlet opening to the engine, the scavenging pump, or the blower. Second, preventing noise due to vibration of the housing of rotary positive-displacement, and centrifugal blowers.

Shell Noise a Problem

The first can be solved by attaching silencing devices to the inlet opening, while the second must be accomplished by blower design. In this era of high-speed superchargers, "shell noise" caused by the acceleration of forces becomes a problem of no small proportions. A good procedure:

Assemble the noisy housing, installing a loud-speaker (diaphragm type) inside the housing, and close all openings with laminated covers. The covers may be built up of three 1-in. boards bonded together with some tacky "gunk." The edges of the openings should be smeared with "gunk" before covers are in place.

The loud-speaker should now be excited by a beat frequency audio oscillator and amplifier. It will be found that there are certain areas of the housing that respond with surprising freedom to some tones and not to others. These areas should be marked and their response characteristics recorded. When changes are made by increasing the thickness, using more ribs, or casting in smaller sections, the test should be repeated and the results compared.

The experimenter will learn from this procedure that the curved stiff sections respond to the higher frequencies and the flat sections of relatively large area to the lower frequencies. Simply stiffening the highly elastic areas is not helpful from a noise reduction standpoint. One must think of rigidity from a dynamic point of view.

The theory of silencing the air intake opening to the high-speed centrifugal blower is relatively simple. The principal problem here is one of good mechanical design. The silencer must be compact, as less space is provided than for the supercharger itself. Here advantage has been taken of the directional effect of high-frequency sound. By using sound absorbing baffles, it is possible to increase the effect of the sound absorbing material. Careful airflow design is required so that friction losses are kept at an absolute minimum.

Discussion of Leadbetter Paper

W. F. Joachim, U. S. Navy Engineering Experimental Station, said the problem of silencing was being solved in actual installations. Sound-level intensities of 85-90 db, or less, are being recorded with large, slow-turning engines, with the overall general engine-room noise being at the 110-115 db level.

There is still the problem of suppressing the "long-distance beats," as he called them, which often carry for several miles over the water. The whole level of ship noise must be continually worked downward, as a safety measure and for the welfare of the vessel's personnel.

The rapid increase in the application of the smaller, high-speed engine, with high specific output, has been accompanied by a great deal of noise. Therefore, Mr. Joachim said, the engine itself must be made more quiet, and the gears, blowers, valve action and actual combustion process itself require a lot of attention. In addition, there is room for improvement in the noise-suppressing qualities of ship bulkheads and enclosures, and in the use of sound-absorbing materials.

Diesel Tests Show Fuel Affects Fouling, Wear

CONTRARY to the almost universal belief that diesel-engine fouling and wear are affected predominantly by lubricating oil, tests carried out by G. H. Cloud and A. J. Blackwood, Esso Laboratories, Standard Oil Development Co., showed that the fuel itself is often one of the causes of the trouble.

The introduction of the high-speed, low-weight-per-horsepower diesel engine, Dr. Cloud, who presented the paper, said, brought the realization that such equipment might be rather sensitive to changes in fuel properties. Test results of other investigators had indicated incidentally that this was so, and observations of automotive diesel equipment in service showed that lubricant characteristics could not in themselves account for the differences in the observed fouling and wear. These reports led the authors to initiate a series of tests designed to study the problem specifically and in more detail.

The investigation covered the testing of over 40 fuels in three different makes of automotive diesel engines. Two of the engines were run in cyclic fashion to approximate field service: 3 min idle and 7 min at 90% rated load. The third engine was run at constant speed and 120% rated load, as those conditions had been reported to be giving trouble in the field on this type of engine.

From these studies, Dr. Cloud explained, it became clear that the selection of suitable fuels is an important factor in the control of fouling and wear in automotive diesel engines. Assuming stability, freedom from water and soaps, and absence of corrosive, abrasive, and residual materials, the major diesel fuel characteristics governing automotive diesel-engine fouling and wear are sulfur content, ignition quality, viscosity, and/or volatility.

Sulfur Content Important

Of these properties, sulfur content is the most important one. Increasing the sulfur content from 0.2% to 1.0% may result in a 40 to 80% increased engine fouling and a two to sixfold increase in ring and cylinder wear. Sulfur in diesel fuels is converted, during combustion in the engine, chiefly to sulfur trioxide, which attacks the lubricating oil, thus producing an insoluble sludge that results in varnish and carbon formation and increased ring and cylinder wear. Apparently the type of sulfur compound present in the fuel is not particularly important.

As regards ignition quality, the minimum cetane number acceptable will depend to a great extent on the sensitivity of the engine under consideration. The data indicate that little improvement in engine condition results when the cetane number is increased above that necessary for smooth operation. Reducing the cetane number below this satisfactory minimum results in increased engine fouling. The effect of the cetane number on engine wear appears to be negligible. Reducing cetane from 50 to 35 resulted in a 10 to 30% increase in engine fouling, but there was no marked change in wear.

Fuel viscosity and volatility may show an appreciable effect on fouling and wear in certain types of diesel equipment. The very close relation between these two factors in normal fuels makes it unnecessary to specify both rigidly. Increasing viscosity from 35 to 40 S.U.S. at 100 F resulted in a 30% increase in engine fouling in two of the three engines studied. However, volatility specifications imposed on diesel fuels to minimize smoke will probably handle this consideration relative to fouling and wear.

Using detergent types of lubricants, Dr. Cloud said, will only partially alleviate the fouling and wear due to the fuel.

The influence of these fuel properties, as determined by the authors, particularly the influence of sulfur on fouling and wear, apparently cannot be applied directly to larger slow-speed diesels in marine and industrial service. A 12-month test on two 13 x 18 diesels in marine service – the

starboard engine on one fuel and the port engine on the other – failed to show unusual fouling or wear on high sulfur fuel compared to one low in sulfur content.

Discussion of Cloud and Blackwood Paper

R. J. Greenshields of Shell Oil Co., Inc., offered substantiating evidence to the paper. He showed slides, revealing the condition of groups of pistons taken from three engines, indicating the effects of operation using fuels of 0.75, 0.50, and 0.1% of sulfur. The base fuel was otherwise an extremely high-grade diesel fuel. These bore out the theme of Messrs. Cloud's and Blackwood's paper. Mr. Greenshields also stated that Shell's experience had been gained from both 2-cycle and 4-cycle engine tests.

The origin of the sulfur content is immaterial – mixed (already present) sulfur, mercaptans, sulfides, and added sulfur, all gave comparable results. In Shell's experience, the foul products of combustion, mainly solid matter, cause some difficulty also. In conclusion, the proper selection of lubricating oil can go far in minimizing the potentially harmful effects of a high-sulfur diesel fuel.

Sulfur Causes Suspicion

Lt. E. N. Klemgard, USNR, U. S. Naval Engineering Experimental Station, said that sulfur was always "suspect," but now definite proof was at hand of its guilt. In response to his direct question, Dr. Cloud was unable to reply with certainty as to the ability of refiners to produce truly low-sulfur fuels. Much of it is combined chemically, and its optimum removal might prove expensive and technically quite involved.

When J. A. Nelson, Standard Oil Co. of Indiana, wanted to know if any of the deposits were water-soluble, Dr. Cloud replied that Oakite and similar cleansers were invariably used, but that water might remove a part of the deposits. Further light was thrown on the subject by F. G. Shoemaker of General Motors Corp., who stated that among his experiences was one of removing with water a certain brown deposit secured from the use of some fuels originating in Southern California. He said cylinder-wall temperatures exert a large influence on engine deposits, and their rate of formation. With relatively cool cylinder walls, so that the incoming air must go through the dew point, cylinder wear has been observed to be 10 times as great as might otherwise be expected. The author agreed that acid corrosion, resulting from too cold surfaces, could be quite bad, but in the tests as made, the problem was really one of SO_3 plus lubricant plus fuel, and not one of SO_3 plus H_2O, the acid side of the question. Even the sulfur content of any additives put into the lubricant can add to the trouble, if and when a portion of the lubricant finds its way into the combustion space. The author said that the lubricant of the 13x18 in. engines mentioned in the paper was thoroughly and continuously centrifuged; even operating with fairly cool walls, the bad effects of any sulfur were not then so apparent.

The subject of spray-injector fouling was brought forward by Lt. Klemgard. Dr. Cloud answered that a high sulfur content appeared to have no deleterious effects upon the nozzles, as long as they run cool, and this is a relative term only when considering combustion-chamber temperatures. In reply to another question, the author remarked that sulfuric acid was present in some de-

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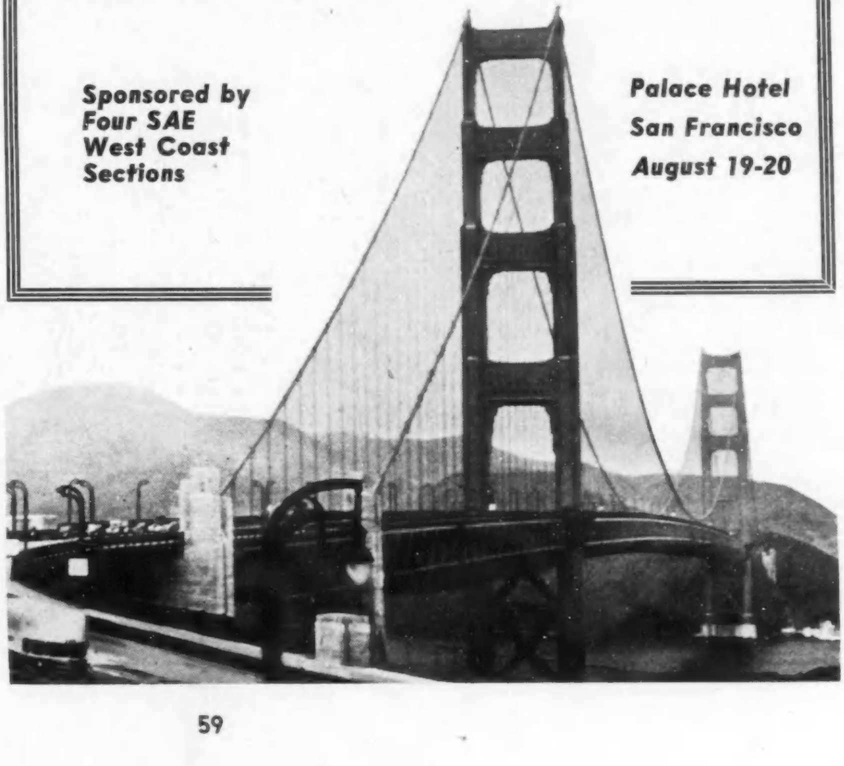


gree in the crankcase oil, but no quantitive determination was made.

Drawing upon his own experience, H. L. Knudsen, Cummins Engine Co., thought it highly desirable to keep operating temperatures as high as possible. He thought he might have to revise his opinion of the carbonic oxides as a cause of wear, and substitute the sulfuric oxides. The aim of the tests made the subject of the paper was the fouling caused by the fuel, and the sulfur was the culprit in this case.

When J. P. Stewart, Socony-Vacuum Oil Co., Inc., attempted to distinguish between the influence of fuel volatility and fuel viscosity, the author replied that it was next to impossible to do so equitably. There is a relationship of interest, and it is difficult to determine which quality has the greater responsibility. The 50% point in the distillation range ought to be about the same, if changes are made in the 10% and 90% points, and then the viscosity will not vary appreciably. "The 50% point and/or the viscosity are both important," Dr. Cloud said.

William F. Aug, Mack Mfg. Corp., inquired as to the effects of a low sulfur content, citing the work of C. G. Williams with gasoline fuels of low sulfur. The author replied that SO_3 is bound to be found with an excess of O_2, but blaming the sulfur for any part of the deposits and wear is a risky business when the per cent of sulfur is definitely low. So many other factors come into the picture that a "balancing-out" process takes place, and blaming any one of these factors, in favor of the other, is out of the question.

When L. E. Hebl, Shell Oil Co., Inc., said he was unable to determine if the same fuel was used in each of the three test engines, the author replied, "Essentially, they were. We ran reference fuels most of the time, but any deviation from this practice would not have altered the observations and results. Cetane number, viscosity and sulfur content are all that matter – even the source of the fuel has no bearing on the final results."

Motor Oils Compared by Laboratory, Field Tests

THE General Motors model 71 diesel, 500-hr laboratory test procedure yields results that are indicative of the service performance of lubricating oils, according to R. S. Wetmiller and Bruce Hegeman, The Texas Co., who carried out an extensive program of testing five experimental oils both in the laboratory and in the field.

However, Mr. Wetmiller, who presented the paper, cautioned, the oil performance is depreciated somewhat beyond that encountered in reasonably heavy-duty service operations due to the severity of the 500-hr test.

The 500-hr laboratory tests and the 60,000-mile service tests were compared on the basis of bearing corrosion, ring sticking, filter clogging, engine deposits, wear, and used oil contamination.

The oils were rated in the same order by both the laboratory and the service tests. Agreement between the two tests was very good with respect to bearing corrosion. Corrosion results of both tests were also found to compare favorably with data obtained in the MacCoull corrosion tester. Similarly, good agreement between the two tests was found with respect to ring sticking, oil ring deposits, piston deposits, Purolator clogging, and used oil examination.

Differences in air port deposits were apparent in the laboratory tests, but in the field these deposits were so light that no differences could be detected. In a similar manner, differences in AC filter clogging were experienced in the field, while in the laboratory, where the filter was changed whenever the oil became dirty, no differences were found.

Cylinder liner ridging was found to be of a random nature, the only consistent observation being that liners with low mileage exhibited little or no ridging. No differences in ring wear were observed between the several oils; however, it appears that wear does not become appreciable until the liner has operated approximately 100,000 miles.

Discussion of Wetmiller-Hegeman Paper

Mr. Stewart observed that air-port deposits are of great importance in the G-M 500-hr test, but that in this paper there seemed to be a lack of correlation. Also, he was not certain as to the intent of the paper as regards the subject of liner ridging. On behalf of both authors, Mr. Wetmiller replied that the results shown could not be considered anything but proof that the air-port deposits were *not* appreciable, and they did *not* affect engine operations during the test. Ridging of cylinder liners was almost in linear proportion to hours run in each case, and the type of lubricant used could not be assigned responsibility for any part of the ridging, in the author's opinion.

Mr. Shoemaker said that the 500-hr G-M test is intentionally very severe. Air-port deposits are apt to be erratic in the field; some engines operate for thousands of hours with no trouble from this source, others may not do so well, industrial engines in general showing more evidence of port-closure difficulties. He believes the oil industry is doing a good job in turning out fuels and lubricants for diesel engines. Mr. Shoemaker also recalled an earlier paper to mind, expressing the opinion that air-port deposits are greatly increased from the use of fuels with high sulfur contents.

24-Hr Test Developed To Study Motor Oils

THE flexibility of the Fairbanks-Morse model 36A, single-cylinder diesel engine as a pre-evaluating tool for the study of heavy-duty motor oils has been demonstrated, according to H. L. Moir, W. J. Backoff, and N. D. Williams, The Pure Oil Co.

This particular engine is well suited for both actual piston temperature measurements and the more common blowby studies, said Mr. Moir, who presented the paper.

The authors have developed a piston temperature measuring mechanism, including a special jig for holding the piston, designed so that the thermocouple wells can be accurately located at any point on the piston. A "make and break" system is used that allows accurate measurements of temperatures from 100 to 1000 F.

A suggested procedure for an accelerated laboratory engine test to evaluate ring sticking characteristics and piston cleanliness with various crankcase lubricants was described by Mr. Moir. A running time of 24 hr per test is used, with the test conditions as follows:

Type of piston	Cast iron
Speed, rpm	1200
Load, hp	9.3
Jacket temperature (ethylene glycol coolant), F	325
Oil sump temperature (not controlled), F	230-240
Volume of crankcase oil, cc	3800

One quart of make-up is added at 10 and at 20 hr, with excess oil drained to maintain the 3800-cc level.

Many tests were run using two reference oils, one poor and the other satisfactory in field operations. These tests showed that consistent ring sticking times and overall cleanliness comparisons comparable with field performance could be obtained under the above set of conditions.

Automatic recording blowby equipment and crankcase sealing were also provided, which simplified the operating detail of the engine in evaluating ring sticking characteristics of the heavy-duty types of lubricating oil or the mineral oil base stocks used for blending. The blowby recording mechanism was successfully used to predict both faulty ring action and ultimate stuck ring conditions for all oils evaluated.

Pistons are rated by the merit system, which gives a rating of 5 for a clean piston with no stuck rings and a rating of 1 for a dirty piston with stuck rings. This engine test procedure allows the evaluation of additive oils as well as base oils.

The authors' experience, Mr. Moir explained, has shown that a 24-hr run on a Fairbanks-Morse engine with a piston rating of 3.5 or better with no stuck rings will give a satisfactory 480-hr Caterpillar test, and consequently saves much costly engine time.

Discussion of Moir, Backoff and Williams Paper

Mr. Hebl confirmed the results obtained by these investigators. A similar set-up used by Shell is invaluable in conducting "screening" tests to determine which lubricants are worthy of a more detailed, longer study. Shell is also using the method for determining the hardness of combustion-chamber carbon deposits.

Theodore M. Robie, Fairbanks, Morse & Co., drew attention to the fact that the test conditions are far above normal encountered in actual service, to which the authors agreed. He wondered, too, why drilling for thermocouples could not be stopped just short of a break through into ring grooves, to prevent any carbon deposits, insulating in action, from being built up on the couples.

Actual operating observations also showed, he said, that this model of Fairbanks-Morse engine gave ring temperatures of about 360-deg outlet jacket temperature; at only 15 lb bmep, the temperature dropped to less than 300 deg. He believed, too, that there is a correlation between ring temperatures and jacket-water temperature. As against the crankcase temperature range of 230-240 deg reported, in normal operation F-M had observed temperatures as low as 130 deg, without a lubricating oil cooler; coolers may often be heaters when a fan and radiator system is used. When aluminum pistons were readily procurable, it was standard practice to use them on 1-, 2-, and 3-cyl engines. Cast iron pistons were used on 4-, 6-, and 8-cyl engines. Clearances had to be different, of course, but no practical differences in operating results could be observed.

In commenting on Mr. Robie's statements, Mr. Moir agreed that there is often a 150-deg difference between normal and high-output values of ring temperatures. However, they found it necessary to accelerate the tests to get measurable results in a short period of time; this, in essence, was the goal of the tests. Pure's experience with cast iron vs. aluminum pistons shows better control of ring side clearance with the former type, and a use period of 500 hr was not uncommon with the cast iron pistons during the accelerated tests. As to the rings themselves, it was customary during the test runs to use but one new ring per piston for each test. This was inserted in No. 2 groove, the ring from the latter going to the top of the piston. The remaining four rings lower down on the skirt were good for five to eight test runs. Visual inspection of the rate of tool-mark removal was the criterion used in ring replacements.

In response to H. C. Mougey, General Motors Research, Mr. Moir answered that there is a correlation of results from the tests in question and the Lawson gasoline-engine tests. The F-M engine has to handle more "soot," which comes from the diesel fuel. Due to the smaller quantity of lubricant charged to the Lawson test, and the 400 F jacket temperature prevailing during the 25 hr of the test, it is possible that the Lawson engine is making use of the detergent qualities of a more or less oxidized oil during most of the run. However, an oil passing the Lawson test will pass the F-M test. Mr. Mougey expressed his concurrence.

When Lt. Klemgard asked if there is an unfailing correlation between observed thermocouple temperatures, as a measure of ring sticking, and visual inspection of the ring in its groove, the author replied definitely to the contrary. Friction, caused by carbon packing behind the ring, may increase temperatures so that the final test is the actual appearance of the ring and groove. He emphasized again that an efficient calibration of the rate of increase in blowby shows conclusively an imminent breakdown of the engine.

Mr. Knudsen expressed his opinion that accelerated tests do not give the true picture, and blowby can be so variable that its value should be questioned seriously. Even minor variations in piston fitting from engine to engine can produce great differences in operating results.

In reply to a question Mr. Moir stated all the tests were run with a sealed crankcase, as only thus could blowby be gaged. The primary purpose is oil evaluation, and the point seems immaterial. The author did state that the use of a dry sump would undoubtedly prolong ring-sticking times.

Sees Less Diesel Fuel Available After War

HIGHER octane gasoline, and more of it; lower cetane diesel fuel, and less of it will be available after the war, as compared with before. This was the warning C. M. Larson, Sinclair Refining Co., had for the designers of diesel engines. "It is up to the diesel engineer to utilize lower cetanes to the utmost," Dr. Larson said, "to offset the vast lead the gasoline-engine designer, especially the aircraft engineer, has through 100-plus octane fuels, which will be available in greater quantities than the diesel fuels after World War II."

Dr. Larson predicted the octane-cetane fuel picture after the war will be approximately as follows:

1. The so-called house brand or regular-grade gasoline will be 80 octane, such as now used by the Army for all ground vehicles using gasoline.

2. The premium grade will be 87 to 90 octane, just above where Buick was when its design engineers had to cut back on the octane requirements of the car.

3. The third-grade gasoline will be 72 to 75 octane for the many serviceable cars left after the war, awaiting obsolescence.

4. Tractor or distillate fuels of 50 octane or 40 cetane will be available.

5. Kerosene or No. 1 fuel as known in the past will be available.

6. Of course, plenty of 100 octane aviation gasoline will be available, but much of the material will find its way into the 80 octane regular or the premium grade 88.

7. Diesel fuels will be available, but in many geographical areas the tractor distillate types of fuel will have to be used with low cetanes (37-40) or cetane additive agents will be added to maintain the 50 cetane minimum, such as called for by the high-speed diesel-engine manufacturers.

The war has brought on an enormous expenditure for the erection of plants to produce high octane aviation fuel. The manufacture of 100 octane gasoline takes place at the expense of kerosenes and distillates (the source of diesel fuels). If the 100 octane conversion takes place at the rate intended, the year 1945 will present a petroleum picture approximately as follows:

	bbl
Gasoline	700,000,000
Kerosene	50,000,000
Distillates	100,000,000
Residual fuels	400,000,000

At least 20% of the gasoline will be 100 octane for aircraft and 30% will be 80 octane for automotive use.

In such a set-up, the gasoline to distillate production ratio would be 7:1, whereas at the start of World War II, the ratio was 3:1.

Discussion of Larson Paper

In the opinion of Dr. G. C. Wilson, Universal Oil Products Co., the refining industry will try to meet the demands as they arise after the war. The diesel industry is well equipped to undertake startling developments, as it already has a vast stock of useful data about high compression ratios, direct fuel injection, etc.

Considerable disappointment was voiced by Mr. Shoemaker in an implied statement that the "diesel engine was on its way out." He believes no diesel designer or manufacturer looks upon today's diesel engine as the ultimate – there is a lot of good hard work to be done, and it is going to be done. Dollar for dollar, Mr. Shoemaker would prefer to spend his money in promoting fuels of high ignition quality (diesel), than in suppressing ignition quality (Otto).

To this the author replied that the intent of his paper was to predict, if possible, what the future would be like, as a result of our present wartime refining program. By no means was the paper a statement of the author's feelings toward the diesel engine, for which he has a high regard.

The preponderance of high-octane production facilities will pose economic problems which the refiner must face after the war; whatever he produces must be at a price which will permit him to continue in business.

Prof. H. M. Jacklin, Purdue University, ventured the opinion that there was much the diesel industry could do to right any possible ill effects, and he believes the industry will do it.

The high efficiency of the diesel cycle commands respect, and cannot be ignored, stated Dr. Cloud. Its advantage in this respect is so marked over the gasoline engine, and in particular at partial loads, that it must be provided for. It will be, he feels, if for no other reason than as a logical step in the conservation of the country's natural resources. Furthermore, the proved advantage of the diesel for two-cycle operation, and for supercharging, are other factors which cannot be submerged.

A. H. Smith, Monsanto Chemical Co., said "The tax structure, which no one can predict, may play a large part in determining where the internal-combustion engine is headed. Purely engineering precepts may be pushed aside when socio-economic factors exert their full weight."

Carl Georgi, Quaker State Oil Refining Corp., inclined to the view that "demand will tell the tale."

As a parting contribution, Mr. Shoemaker said that certain diesel engines of G-M manufacture had successfully burned gasoline on a fighting front, and that in a certain test a diesel operating on 80-octane gasoline gave 30% more mileage than a comparable gasoline engine with the same fuel, and under the same conditions.

Lubricants for Ordnance Improved, Standardized

ONE type of engine oil in three grades instead of the two types and ten grades previously considered necessary; one grade of gear lubricant instead of the two types and seven grades formerly used – these were the major advantages mentioned by Major R. E. Jeffrey, Ordnance Department, as accruing from the lubrication standardization program carried out by Ordnance in the last two and one-half years.

When this project was started, Major Jeffrey said, there were no standard lubricants for military vehicles; consequently, a wide variety of types and grades of these materials found their way into tanks, scout cars, jeeps, and other items of Army equipment. The most serious result of this situation was the frequent misapplication of the type and/or grade of lubricant – from the large variety available. The supply problem was also beginning to become serious. Obviously, the fewer the number of items to be supplied, the more efficient the supply system would be in providing a sufficient quantity of the proper materials for the fields of operation.

There were seven types and 22 grades of lubricants for automotive equipment alone, not including those for special purposes. The first step taken was to describe, wherever possible, each type and grade of lubricant in terms of some federal agency specification already in existence.

The problem then resolved itself into four parts:

1. Establishing and maintaining an efficient system of lubrication instructions for issuance to troops.

2. Reducing the number of types and grades of lubricants to a minimum consistent with satisfactory performance.

3. Developing these types and grades to

fit most satisfactorily the military applications involved.

4. Developing satisfactory U. S. Army specifications to cover adequately the necessary materials.

Major Jeffrey confined himself to a discussion of the latter three parts.

In connection with the work on engine oil and gear lubricants, it was necessary to consider low-temperature applications, particularly pumpability, to facilitate cold-weather starting and warmup. This problem was presented to the War Advisory Committee of the Cooperative Research Council. The recommendations made by the special committee set up to advise the Ordnance Department were embodied in lubricants later tested under cold-weather operation, with most gratifying results.

Greases and engine preservative oils were also studied, resulting in improvements in both. The developments in greases were made particularly to give better cold-weather operation. One of the main problems studied in respect to the preservative oils was that of reducing the number of critical materials. An entirely new specification was prepared to cover an engine preservative oil that would possess the dual properties of adequate lubrication and preservation without being wasteful of critical materials.

Discussion of Jeffrey Paper

Mr. Knudsen deplored the withdrawal of the SAE 20 motor oil, preferring its retention to that of SAE 30. He also wondered why only two engines, the Caterpillar and General Motors, were used. To this, Major Jeffrey replied that these two engines are regarded, for purposes of evaluating and approval of lubricants, solely as laboratory tools. Any commercial implication is ignored. He added that the 36-hr Chevrolet test is also used, and all tests are supplemented by constant checks in field service units. The choice of SAE 30 was the best compromise for *all* engines used by the Army.

In response to a series of miscellaneous questions, from Messrs. Mougey, Bird, Stewart, Knudsen and others, the author gave additional details.

Oils submitted for approval must be accompanied by forms properly filled out, showing the origin and trade names of base oil and additives. This is necessary, even where either component may already possess an approval as a part of an oil submitted at an earlier date. The data on Form 2-104B is required, even though it duplicates that on Form 2-104A, for oils having qualification numbers; new numbers are given to new products, and this includes the case of brand names wherein the oil composition has been changed or altered in any way. Reviewing committee meetings at Armour Institute are held about every three weeks.

As yet, Army regulations do not permit the use of Army qualification numbers on containers sold to civilian and commercial channels. This is now under review.

Compatibility tests of mixtures of qualified oils have been and are being made; diluted oils (for cold weather service) are *not* resulting in more rapid wear of moving parts; approved oil filters do not remove additives; except for form C-4, not submitted with the paper, which refers to the 36-hr Chevrolet test, a number rating system is not used when oils are evaluated; the Quartermaster Corps checks all oils received (those qualified and purchased in the regular course of events) for physical properties as set up in the various specifications, and continual in-service checks are made.

Special Military Type Of Engine Is Proposed

THE quantity of equipment needed to wage this war, and the urgency of the need, were only met because the automotive industry had designs for fairly satisfactory engines, and the facilities to produce them, declared Lt.-Col. Carl E. Cummings, Tank-Automotive Center, Detroit. Needed improvements were made as the need arose, at no sacrifice of the quantity produced, but it may now be the time for the industry to undertake the development of engines designed solely for their suitability as weapons of war.

Existing designs were not perfect, existing engines are not perfect; and the author then proceeded to outline some of the factors to be considered in building an efficient, single-purpose military engine. It is a real challenge, as evidenced by the 150,000 hp of engines required for an infantry division, the 250,000 hp for a motorized division, and the 400,000 hp for an armored division consisting of 3321 vehicles of every description. Furthermore, all the services, transport, combat, construction, require the use of 57 different models of engines.

Col. Cummings stated that the requirements of military operation are much more severe than any commercial service for which most of these engines were originally designed. With this in mind, how best to go about the design of units to be specifically military ones? The guide posts are three – suitability, reliability, fuelability.

Any new design should fit perfectly the service for which it is intended. Tank powerplants, in particular, should be of high-output density type, to provide a low weight at minimum space expenditure. Brake horsepower should range from 12 to 20 per ton of weight of the vehicle to be equipped; these figures contrast with 5½ to 15 hp per ton of weight now existing for certain medium tank units.

Aircooled engines of the radial type have simplicity in their favor now, but progress is needed in a reduction of the headroom required for their accommodation. Liquid-cooled engines have this latter advantage, but need cooling systems of small radiator frontal areas. If the suitability is right, many of the reliability items will be taken care of automatically. Engine models must, as far as possible, use common components, as the maintenance and supply problems are reduced greatly thereby. Installation details must be accorded greater attention, and, the Colonel warned, the integration of accessory items with the main power unit must be at a more efficient level than ever before.

For example, our intake-air filters are very excellent devices, but dust is still *the* problem because of the inadequacy of the connections between the filter proper and the engine intake header.

Reliability will be achieved only after we expend some effort and thought on these problems, to name just a few: Cooling systems, cold starting, electrical system protection from the elements, the problem of adequate lubrication at slopes as great as 30 deg, improved testing procedures for engines before they are released for active service.

This latter point is now receiving the attention of the Ordnance Department, a 500-hr test procedure having recently been instituted. Briefly, it consists of two similar 250-hr runs, with cyclic variations of speed vs. load, time vs. idle and fuel loads, and sustained overspeed operation.

The problems of fuelability have never been easy. Both quantity and quality are important, are related, in a measure. When specific fuel consumption can be reduced because of improvements in engines *and* fuels, the savings in transportation and storage may prove amazing. To illustrate this point, the Colonel stated that a 3% saving during the height of the Tunisian campaign would have made unnecessary one tanker trip per month. And, he added, the 0.85 lb of fuel per bhp-hr we are getting from one gasoline engine just isn't good management.

The necessity of supplying large stores of aviation gasoline has complicated the problem considerably, as it has meant the handling of three fuels – aviation gasoline, motor gasolines, and diesel fuel. Not very much has been accomplished in dieselizing an entire tactical unit.

In the first place, the engines could not have been secured in sufficient quantity, and secondly, since we must handle gasoline anyway, the problems of after-dark transport and delivery are less troublesome if gasoline, rather than gasoline and fuel oil, is the thing to be moved. This is no reflection on the safety of making an erroneous dumping of a tank's contents in the dark, to equipment which cannot possibly use it.

The Colonel ended by suggesting that a new series of designs, to use fuels lying between the high-octanes on one hand and the high-cetanes on the other hand, might be worked up with fuel injection incorporated.

We have good equipment now, but we need better – averages are "out," and only the top performances count. The most successful military engine, concluded Col. Cummings, will be the one of the fewest, most interchangeable parts, and amenable to the widest variety in fuels.

Discussion of Cummings Paper

H. S. Manwaring, International Harvester Co., felt that fuel versatility is a most desirable goal to aim at in future engine designs, and fuel injection appears to offer the most hope right now toward achieving such a goal. H. F. Bryan, of the same company, stated that tractor engine builders had accumulated a good stock of dust control knowledge, and questioned if the tank designers had availed themselves of this data. He said it was the last few per cent of dust that does the damage, and the discusser asserted that although extremely fine, the dust thus represented accounts for the largest quantity of individual particles composing the 100% volume of air passed through a filter.

Col. Cummings said test data accumulated to date by the Ordnance Department would not warrant any definite conclusions about the possible ill effects of the microscopic dust particles which find their way into engine air systems.

In response to a question by R. E. Cummings, Thompson Products Co., the Colonel said that most other warring nations were using conventional types of automotive engines as tank powerplants. The British use a V-type gasoline engine, as well as the G-M Model 71 diesel and a British diesel. The Germans use a V-12 model, rated for 70-72 octane gasoline, and the Russians operate a V-12 diesel.

Mr. Shoemaker's statement, "there are two sides to every penny," touched on the subject of engine reliability. The one side is the Army, the other is the engine, and both can stand improvement.

Ingenuity Essential in Repair of 'Sub' Diesels

THE solving of diesel maintenance problems of the Navy, particularly for submarines, generally requires considerable ingenuity – much more than is appreciated by those of us at home within a few minutes' telephone conversation of the manufacturer of the repair part needed. So that we may better understand their problems, some of the maintenance jobs facing the repair crew of a submarine in a remote part of the world were explained by Lt.-Com. R. J. Moore, Navy Department, Inspector of Machinery, Cleveland Diesel Engine Division, General Motors Corp.

The troubles that can arise when a repair job comes up many thousands of miles and perhaps months of shipping time away from manufacturers, when all repairs have to be made from material on hand or improvised, were well illustrated by Com. Moore in the story of a job that had to be done at Manila a few months before the war. One of the crankpin bearings on a submarine main engine wiped and seized, scoring the journal so badly that, at first, renewal of the shaft appeared to be the only solution. But stripping a submarine engine down to the point where the crankshaft can be changed is not something to be undertaken without much serious thought. The boat is waterborne, hence even in the calmest water there is motion. All weights must be lifted with chainfalls unless a riveted section over the top of the engines is removed in order to permit the tender to use its booms. That riveted section takes time to remove and replace, and while it is off, the submarine cannot dive.

Measurements showed that the journal was not beyond repair, provided a portable grinding tool could be found. Needless to say, there was none in Manila; and from radio communication with the manufacturer, it appeared that none had ever been made for this type of bearing. Plenty of portable grinders were available that could grind the pin back to a reasonably accurate state of roundness, but it was also essential that the axis of the undersized journal be the same as that of the original.

Fortunately, the service engineer from the engine company was available. With some assistance from the submarine's engineer officer, he designed and built a portable grinder. When finished, it was a somewhat weird looking piece of machinery, but it worked. Fitted with a special bearing flown out from the States, the engine ran full power for many hours before the war started, without a sign of trouble.

In an effort to overcome such problems as this, replacement parts must be stored all over the world. Because of the delays in shipping and the possibilities of losses through warfare, it is necessary to anticipate by many months the parts required.

Admittedly, the use of replacement parts is excessive when engines are overhauled. Some of this is due to the inexperienced personnel, who, realizing their own lack of knowledge, put in a new part when they are in doubt, even though the old part may have several thousand engine hours of useful service left in it.

When engines are installed in ships that are going to face the enemy, the Navy naturally would prefer to err on the side of safety.

When an engine breaks down at sea, it may mean the Jap ship or the Nazi sub that should have been sunk is left to carry on its deadly work. It may mean our own ship is lost, if that broken-down engine is needed to escape from a superior force.

When maintenance crews become more experienced and overhaul facilities improved, it is anticipated that the replacement parts problems will be under better control.

The lack of trained operators is also receiving its share of attention. The Navy is now about a dozen times as large as it was a few years ago. It used to be possible to do practically all the training on board ship, where new engineers could be trained under the guidance of more experienced men. With expansion, this process became too slow.

In Cleveland, adjacent to the Cleveland Diesel Engine Division Plant No. 3, there is a school that gives students, who already have a faint knowledge of diesel engines, a six-weeks training period. Unfortunately, in this short time, little can be done except attempt to give the students the details of the particular type of engine they can be expected to encounter when they leave.

Since a majority of the students have had little diesel experience, it is important to make them understand that if they will but keep their engines clean, properly lubricated, and adjusted, the engines now being manufactured will give excellent service and a large portion of the maintenance problem will be eliminated.

Discussion of Moore Paper

Upon a question from the floor, Com. Moore said a submarine normally carries engine spare parts such as connecting rods, heads, pistons, blowers, piston rings, etc. Many repair jobs, such as crankshaft reclamation, are problems to be solved only at a base or by a tender, where facilities are greater.

Light Weight Diesel Developed for Navy

A MARINE diesel engine weighing only 4 lb per hp – that was the remarkable result of the nearly five years of development work carried out by General Motors in cooperation with the Diesel Engine Section of the Bureau of Ships. The story behind this accomplishment was told by J. C. Fetters, Electro-Motive Division, General Motors Corp.

The engine arrangement is a very unusual one. The 16 cyl are arranged as a 4-bank radial engine to meet the Navy requirements of minimum space and light weight. Since a gear reduction to the propeller shaft was necessary, and since length and weight of engine foundation were of importance, it was decided that the most economical arrangement would be to place the engine in a vertical position on top of its gear box, and to obtain the reduction through a pinion and ring gear in a right-angle drive.

The connecting-rod construction proved to be one of the chief problems. The slipper type was finally chosen. With this construction, Mr. Fetters explained, there are four connecting rods bearing directly against each crankpin, but due to the articulation, the arc that could be subtended by each rod pad was only 66 deg, and this resulted in a very high loading. It was necessary to make a special test machine to develop this bearing construction to the point where it had sufficient life.

Since the engine is of the 2-cycle type, it was necessary to have an engine-driven blower. The centrifugal blower was chosen as offering the best chance of fulfilling the space and weight requirements. The rated output of the blower is approximately 4000 cfm at 6 psi gage discharge pressure. The complete assembly weighs about 100 lb.

To save time and forestall possible trouble in the future, many of the subassemblies were constructed and tested before putting them in the engine. This procedure proved quite advantageous, since when the engine was assembled and run no trouble was experienced with the pretested pumps, blower, and other accessories.

The crankcase is a completely welded one-piece structure. It is built up in layers of 4 cyl radial elements at a time. The main stress members are alloy steel, X-shaped plates running in a horizontal plane, and spaced apart by hexagonal-shaped plates.

The arrangement of intake ports and exhaust valves is similar to all General Motors 2-cycle diesels. The uniflow system is employed, that is, the air enters the ports in the cylinder barrel, and blows straight through the cylinder and out through the exhaust valves.

The piston consists of a forged steel head and a skirt made from steel tubing welded together just above the ring belt. There are no wristpin holes through the piston skirt. There are two forged steel trunnions on either side of the connecting rod, which are bolted directly to the head forging. A silver-plated floating bushing is used between the connecting rod and the wristpin.

The engine, General Motors model 16-184-A, is capable of delivering 1200 bhp on the test stand, although the continuous-duty power rating, of course, is less.

Discussion of Fetters Paper

Questions by Mr. Robie, J. O. McReynolds, and Maurice L. Hamilton signified the interest of the entire audience in this paper. The author therefore gave additional details regarding the "pancake" engine.

The centrifugal blower runs at 10 times engine speed, or 1800 rpm, at rated speed, delivers a maximum of 4000 cfm at 6 psi gage pressure, and requires 185 hp to drive at rated maximum. The blower proper weighs about 100 lb.

Engine idling speed is in the 550-600 rpm range; fuel horsepower load tests at this low speed have shown the blower capacity to be quite adequate.

No specially high cetane fuel is required – it is Navy Specification material of about 50 cetane. Specific fuel consumption is 0.44 lb per bhp-hr at 80% power and 90% speed condition, and 0.45 lb per bhp-hr at rated output of 1200 hp. Starting presents no problem, about 380 lb compression pressure being attained at the 75 rpm cranking speed. Considerable use is made of silver plating for bearing surfaces. Piston pins, full-floating, are so treated, as are the entering faces (in direction of shaft rotation) of the connecting rod slipper bearings. The silver is durable, and no wearing problems have occurred.

Welded steel construction is used throughout where possible, accounting for the wt/hp ratio of 4:1 secured.

SAE War Materiel Meeting

continued from page 27

Looking to the future, Admiral Davison concluded:

"As time goes on we expect more and more to come from the automotive industry in the form of improved materials and processes. When the newer designs come to take their places on the assembly lines, as they are coming, we hope for smooth changeovers instead of major upheavals that will rob us of months of production and disrupt the developing working forces.

"The Navy is striving to do its part in assisting Naval contractors to reach a maximum output and to gain efficiency, so that our war production effort will be carried out to the best advantage of the nation. To this end the engineering and production branches of the Bureau of Aeronautics are making every effort to cooperate with you. The resources of the trained engineers of the Navy are ready to help out in any way within their power."

The first paper presented, "Lessons Learned from World War II About Designing for Accessibility," by Col. E. S. Van Deusen, Tank-Automotive Center, appears in full beginning on p. 36 of this issue.

There was no discussion of Col. Van Deusen's paper.

The paper presented by J. O. Almen, General Motors Corp., entitled "Shot Blasting to Increase Fatigue Resistance," appears in full in this issue beginning on p. 248 of the Transactions section.

Discussion of Almen Paper

Questions concerning the final surface of shot-peened parts were answered by Mr. Almen in discussion. He told Merrill C. Horine, Mack Mfg. Corp., that, although shot peening roughens the surface somewhat when done after grinding, this surface has proved entirely satisfactory for many automobile parts in the manufacture of which shot peening is the final operation. Where extra smoothness is required, he added, a light lapping operation after peening gives satisfactory results. The effect of plating after peening is probably bad, he informed Kenneth W. Finch, Bendix Products Division, Bendix Aviation Corp., because of hydrogen embrittlement. However, shot peening increases corrosion and abrasion resistance.

Tank Suspension Design Disclosed

THE suspension has an important effect on all of the three military characteristics that are essential for track laying vehicles – namely, mobility, fire power, and protection – Lt.-Col. J. M. Colby, Tank Automotive Center, pointed out early in his presentation. Speaking on the subject: "Suspension for Track-Laying Vehicles," he explained that suspensions affect fire power because they provide a stable or an unstable firing platform; they affect mobility because ride is a main factor limiting cross-country speed; and they affect protection because speed itself is protection.

Suspension development, Col. Colby continued, also must be viewed from its effect on the essential mechanical characteristics – reliability, accessibility, and simplicity. Suspensions affect reliability of the vehicle as a whole because ride qualities protect the mechanisms and personnel from shock. Accessibility is essential for field repair – the vehicle must be kept running on the battlefield. Simplicity is also necessary not only from the standpoint of ease of production, but also from the standpoint of simple maintenance.

A third basis for judging suspensions, he went on, is that of essential component characteristics which require that the suspension must function as intended and be of minimum weight and minimum bulk. Stressing the importance of saving every possible pound, Col. Colby pointed out that the saving of 40 lb in the suspension or elsewhere in the vehicle will permit an additional square foot of armor 1 in. thick over some vulnerable portion of the tank. Minimum bulk is necessary in order to leave a maximum of hull space to stow ammunition and to service weapons.

Illustrating his points with slides, Col. Colby then reviewed the development of tank suspensions from the "rigid" suspensions of the pioneer tanks of World War I to modern designs, discussing the following types: cable, hydraulic, laminated-spring, individually sprung wheel, and four-wheel bogie system with volute springs. He displayed curves of accelerometer tests that demonstrated that the individually sprung wheel type of suspension gave a better ride than the four-wheel bogie type with volute springs. The individually sprung wheel type of suspension had to be abandoned, however, he explained, because it occupies too much hull space.

Compromise Necessary

This example, he pointed out, typifies the compromise in design components that must be made in the completed vehicle. While excellent solutions may be found for each component, he said, the essential design must be a compromise with other components when viewed from the standpoint of the vehicle as a whole. Hence, new design can usually be criticized from several points of view: It is too heavy, or it doesn't have enough armor plate; it is too bulky, or it doesn't have sufficient room for crew and storage; it is too high, or it doesn't have enough fire power. These arguments, he pointed out, are never-ending.

"However," he concluded, "because each of our components has been able to meet the requirements just outlined, we are able to state today, without fear of factual contradiction, that our tanks have more fire power, more mobility, and more armor protection than any other tank of comparable weight on the far-flung battlefields of this war."

Discussion of Colby Paper

In discussion Col. Colby answered questions raised by Mr. Horine, A. S. Krotz, B. F. Goodrich Co.; Chairman Harry T. Woolson; and Tore Franzen, Chrysler Corp.

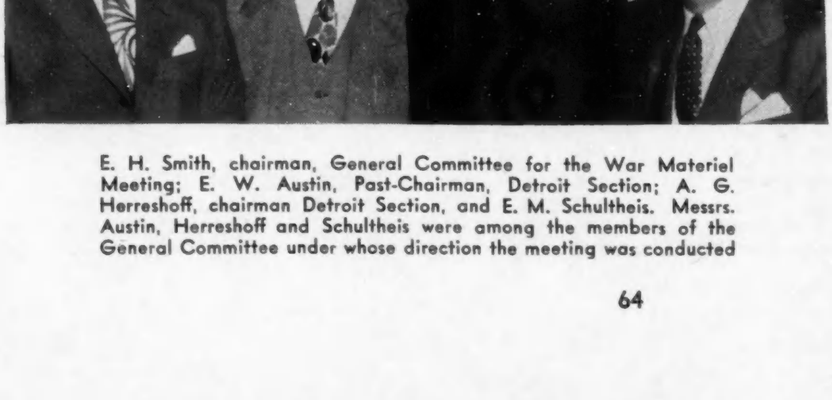
He told Mr. Horine, who asked whether the accelerometer was found to give a valid indication of riding ease, that the accelerometer usually agreed with human reactions in the ride of tanks. The main requirement, he said, is to get a deep, soft spring ride. The difference between tank and commercial vehicle ride requirements, he said, probably accounts for the fact that Mr. Horine got more valid results with a seismograph than with an accelerometer.

At least 8 in. vertical wheel scope in compression is required, he told Mr. Krotz, adding that compensation is needed.

To Chairman Woolson's question about the effective range of tank guns, Col. Colby replied that the M-3 and the M-4 are knocking out German tanks at 2800 yd.

Asked for information on captured German tanks by Mr. Franzen, Col. Colby confined his remarks to the synthetic rubber used for track pads which he reported to

Active in Meeting Arrangements



E. H. Smith, chairman, General Committee for the War Materiel Meeting; E. W. Austin, Past-Chairman, Detroit Section; A. G. Herreshoff, chairman Detroit Section, and E. M. Schultheis. Messrs. Austin, Herreshoff and Schultheis were among the members of the General Committee under whose direction the meeting was conducted

be of inferior quality. Samples were in a chipped and dried condition when captured.

The paper "Engines for Tanks" by Lt.-Col. R. J. Icks, Engineering Manufacturing Branch, Tank-Automotive Center, is given in full beginning on p. 39 of this issue.

Discussion of Icks Paper

That the perennial debates between proponents of diesel versus carburetor engines and of air cooling versus liquid cooling are still going on became evident immediately in discussion of Col. Icks' paper as discussers rose to challenge various points brought out in favor of aircooled diesels for tanks.

To Chairman Woolson's point that cooling fins on aircooled engines collect dirt just as do radiators on liquid-cooled engines, Col. Icks expressed agreement. Mr. Woolson also contended that carburetor engines are more reliable – give longer service, with less maintenance.

Experience in marine engines indicates that the *fire* hazard of diesel fuel is greater than that of gasoline, Mr. Horine contended, as the diesel fuel will creep. He conceded that gasoline is a greater *explosion* hazard than is diesel fuel, but argued that, if all tank explosions are ammunition explosions as he had heard, the fuel makes little difference. Col. Icks countered that, if you have two fire hazards in a tank and can eliminate one of them, the tank should be safer as, in his opinion, gasoline is both more inflammable and more explosive than is diesel fuel. Mr. Horine also inquired how it is that water-cooled engine trucks that accompany tanks are able to get cooling water. Col. Icks replied that when the tanks go into combat, they leave the trucks and may have to run for long periods in barren country where water is unavailable.

Asked about the accessibility of aircooled tank engines, Col. Icks reported that accessibility will improve with a better arrangement of baffles and improved design of the interior of the engine compartment.

Compares Inspection Methods of Wars I & II

AFTER sketching the history of precision from the earliest days of man to show that progress has been continuous, O. J. Snider, Cadillac Motor Car Division, General Motors Corp., compared the inspection methods and equipment used during World War I with those being employed today. His paper is entitled: "Progress in Precision – Inspection Methods through the Automotive Age to World War II." To illustrate his comparison, Mr. Snider used a specific part – the aircraft crankshaft, contrasting the inspection of the crankshaft of the Liberty engine of World War I with that of today's Allison engine. He explained that the aircraft crankshaft was selected because it covers practically all kinds of measurements used in checking a machined part.

To show the increase in the requirements that aircraft crankshafts must fill since World War I, Mr. Snider reported that the Allison crankshaft must transmit 360% more power than the Liberty engine crankshaft; that the weight per horsepower is 60% lower with the Allison crankshaft weighing 10% less than the Liberty crankshaft. Starting with a comparison of the forging billet inspection, he reported that the Allison inspection has added the following procedures not employed for the Liberty crankshaft billets: transverse fatigue test, spectographic analysis, McQuaid-Ehn grain size test, end-quench hardenability test.

Displaying a slide, Mr. Snider showed how the flow lines of the forgings are checked. He explained that, although the Allison crankshaft is made of SAE 4340 steel, the specimen for checking the flow lines is made from SAE 1045 steel which has greater segregations and etches up sharper to disclose the flow. Tests made on the test coupon from the finished forging include tensile, Izod, fracture appearance, and Brinell hardness of both crank and coupon.

In summarizing the advances in floor inspection Mr. Snider reported that workers are more specialized; electric gages replace micrometers and calipers; fixed step gages replace height gages; special gages, comparators, electrical and mechanical, supersede verniers; progressive or double-end interchangeable gages replace double-end plug, snap, and bar gages. In addition greater interchangeability is provided; modern optical and electrical instruments permit greater efficiency; and gages have longer life because of diamond- and carbide-tipped instruments.

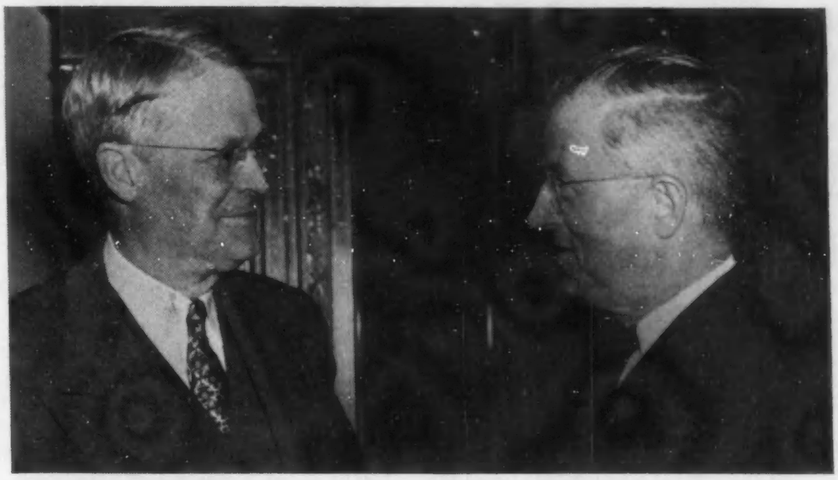
Turning to balancing, he compared the old method of rolling the part on horizontal straight edges with the modern balancing machine which rotates the crankshaft in a rocking cradle, and which magnifies and indicates optically on a screen in front of the operator, both the amount and position of the imbalance. The old method, he pointed out, indicated static out-of-balance only, whereas the present method shows both static and dynamic characteristics.

Describes Latest Development

The latest development of precision checking methods, he announced, is the master steel block step gage, designed to facilitate measurements that previously required the used of vernier height indicators and surface plates. In reality, he explained, it is a set of "Jo" blocks conveniently arranged according to the dimensions desired.

After completing his comparison of crankshaft inspection methods, Mr. Snider described some of the outstanding inspection methods used on other parts. This description included multiple-contact electric gages for accurate high-speed checking of shell and propeller-hub dimensions; internal comparators; and an electrical telescope borrowed from the surgeon's instrument bag that can see around corners to scan drilled oil passages, intersecting holes, and so on, for flaws or imperfections.

Three Session Chairmen



John H. Hunt and John G. Wood, above and Harry T. Woolson, right

Chairman Lenz announced that the time alloted to discussion of Mr. Snider's paper had been turned over to Capt. F. A. Gitzendanner, Assistant Chief, Inspection Section, Ordance Department, Tank - Automotive Center, to discuss a subject that concerns the administrative phase of inspection, namely the application of statistical methods of quality control.

Explaining the Ordnance inspection problem and how it differs from that of the manufacturer, he said that Ordnance must ascertain that relatively large lots of material presented for acceptance are actually up to specification. Ordnance must establish inspection procedures which will be adequate and fair to all producers and, for many tank automotive items, producers are counted in dozens and use equipment and methods ranging from the best to something "hardly that." Although Ordnance is somewhat relieved of the necessity for determining causes of defects, he emphasized that the requirement for protection and uniformity is rather extreme.

As a solution of the problem of establish-

Military Speakers

Lt.-Col. J. M. Colby, Col. E. S. Van Deusen, and Lt.-Col. R. J. Icks

ing uniform acceptability levels, Capt. Gitzendanner continued, the Ordnance Department as a whole has turned toward quality control inspection methods. Quality control methods, he explained, are peculiarly well adapted to the inspection of items like ammunition, armor plate, or any number of others where the only possible tests are destructive. They have been successfully used on these tests, and it followed that they be used in the inspection of nondestructible features of these same kinds of material.

Answering those who question the value of quality control methods on automotive equipment, he declared: "Gentlemen, the volume is there, the precision skill is there, and we're just missing a good bet."

Quality control inspection methods, he announced, have been in use for a period at several facilities on some tank components. To institute such programs Ordnance first decides what percentage of defective material of a given kind can be tolerated. Acceptability levels are accordingly set for various items and published to the Ordnance Districts. These levels are used in conjunction with a standard Ordnance inspection table. This plan is set up initially on a "go, no-go" basis. However, he pointed out, the quality control also can be set up on a "variables" basis which permits the use of precision instruments and which gives industry control over faults as they develop, thus permitting corrective action before rejections occur.

Such a system has three principal advantages, Capt. Gitzendanner summarized:

1. It gives Ordnance the protection that it requires,
2. It provides a uniform basis of acceptance for industry, and
3. It removes from the Ordnance inspector the responsibility of decision.

Speaking from experience with this system, Ira Maxon, Deere & Co., pointed out that such a system of quality control is not an inspection process, but is a method of determining how well inspection is done. He reported that the method has shown the following advantages: the quality of the product is definitely raised; the equipment is kept up better – gages don't wear so rapidly; Ordnance is better protected; and it forces the producer to go back to the source of errors that cause rejections. As to its accuracy, he testified that a check of the method against 100% inspection gave 28½% rejections by the quality control method against 29% rejections by 100% inspection.

Another "extra added attraction" concluded the session program – the showing of a sound moving picture: "The Beginning of the End," which dramatically told the story of the conversion of the Linden, N. J., plant of General Motors Corp., from the assembly of automobiles to the manufacture of naval aircraft. The picture was shown through the courtesy of the meeting's dinner speaker, Rear-Admiral Ralph E. Davison, Bureau of Aeronautics, Navy Department.

Tractor Dust "Know-How" Aids in Military Study

WARNING that the dust problem has steadily resisted any "universal" solution, L. F. Overholt drew upon the tractor industry's 30 years of experience to suggest for application to military vehicles a variety of means for providing better protection against dust. Mr. Overholt, who is assistant to the chief engineer in charge of engine and tractor development, International Harvester Co., is a member of the SAE War Engineering Board's dust technical committee which currently is studying dust problems for the Ordnance Department. His paper is titled: "Dust Problems in Military Vehicle Operations."

The average oil bath air cleaner in commercial use on tractors is practically 100% efficient in extracting dust particles larger than 10 microns from the air stream entering the engine, Mr. Overholt stated, but added that: "Dust particles smaller than 10 microns constitute a serious wear problem in some sections of the country." Nevertheless, he continued, a well-designed cleaner will remove from 80 to 95% of these finer particles for an overall cleaner efficiency of 97 to 98% weight.

Dust Wear Described

Results of tests made by C. T. O'Harrow, Allis-Chalmers Mfg. Co., of dust from Phoenix, Ariz., St. Anthony, Idaho, and West Allis, Wis., were reported to Mr. Overholt as showing that: (1) regardless of origin, a distinctly different rate of wear is produced by fractions in the various size ranges: (2) a 15- to 30-micron dust produced approximately 2½ times as much wear as the 5- to 15-micron dust – and the 5- to 15-micron dust produced approximately 1½ times as much wear as the 0- to 5-micron dust; (3) there is some difference in the wear produced by the dust of different origins. West Allis dust produced the highest rate of wear – and Phoenix dust the lowest.

Stressing the more-difficult-than-commercial conditions under which military vehicles must operate, Mr. Overholt listed as the chief problems in dust-proofing engines for mechanized war equipment the following:

1. To provide an accessible location for the air cleaner where it will not be subjected to high temperatures and can be serviced without the use of tools;
2. To locate the air cleaner inlet in a zone of low dust concentration as a means of increasing the service interval of the cleaner;
3. To save oil and to save service time;
4. To provide simple but durable connections between the engine and the air cleaner;
5. To provide a filter for the engine crankcase ventilating system;
6. To seal the oil level bayonet gage.

Aside from engine problems, Mr. Overholt pointed out, dust protection of the power train, running gear, electrical equipment and controls also offers many difficulties.

Tank clutches, he mentioned, cannot be as completely enclosed as in lighter vehicles – and deflector shields are of little value. He suggested the possibility of eliminating the clutch housing and depending on the wind created by the clutch and centrifugal force to throw the dust out.

Clutch throwout bearings for open clutches must be the fully enclosed, permanently lubricated type, he stated, else they will fail in a few hours.

Discussing dust entrance into electrical equipment, Mr. Overholt said that magnetos, even to drive shafts, have to be completely enclosed to prevent dust entrance – and that battery distributors require similar treatment. Generators, controls, instruments, brakes, cooling systems and fan belts were other vehicle elements subject to harm from excessive dust which were discussed by Mr. Overholt.

"The dust problem is a real enemy that cannot be defeated by halfway measures," Mr. Overholt concluded, adding that continued effort has reduced wear in tractors caused by dust to an acceptable minimum and that although mechanized war equipment offers many new problems, "with the ingenuity of the American engineer these will be solved."

Discussion of Overholt Paper

The extent and gravity of the dust problem was brought home graphically to those in attendance by two motion pictures and by numerous slides. The first moving picture, displayed by Mr. Overholt, showed a tank operating under various conditions on the desert. The second film was shown by Capt. D. A. Nichols, Tank-Automotive Center. It depicted Ordnance dust tests in the desert, showing test instrumentation and procedure.

Particle-Size Tests

S. B. Tuttle, Detroit Diesel Engine Division, General Motors Corp., contributed information on the results of recent particle-size tests. These tests indicate, he reported, that rate of wear is not due to particle size but to the number of particles. He pointed out that these results did not seem in agreement with those of similar tests made at Allis-Chalmers which, according to his understanding, emphasized particle size. Contending that the two tests agreed more closely than Mr. Tuttle had indicated, Mr. O'Harrow pointed out that the Allis-Chalmers tests compared the wear obtained from 1 gm of large particles with that obtained from 1 gm of small particles. Expressing agreement with Mr. O'Harrow, Mr. Tuttle pointed out other differences between the two tests that must be taken into account, for example, the Allis-Chalmers tests were made on a gasoline engine; Detroit Diesel's on a diesel.

Aviation Phase

Asked by Chairman Wood to discuss the aviation phase of the problem, Capt. Nichols emphasized that its seriousness depends upon how light the dust is. He reported that tests in both American and African deserts have indicated that planes must fly above 15,000 ft to reach an atmosphere that is free from dust. He reminded that the motion pictures had shown the tendency of the dust to rise.

Pointing out that desert farms were shown in the motion picture last displayed, A. W. Scarratt, International Harvester Co., emphasized the many years' experience with the dust problem that has been accumulated by the tractor industry. Tractors have to live in this country and do their job, he declared, and tractors must work at the slowest farm speeds due to the solidity of the ground and cannot run out of their own cloud of dust as can military vehicles. In addition, every farm tool is an effective dust agitator.

"If advantage had been taken of this experience of the tractor industry earlier," he contended, "we would be further along in the solution of the dust problem."

Effect on Distributors

The effect of dust on distributors was introduced by Capt. R. W. Hogan, Tank-Automotive Center. In the ensuing discussion with Mr. Overholt it was brought out that it was not until a dust box was set up and conditions made severe that it became known what the problems really were. Enough silicon is present to break down and form glass. Breaker arms stick up with dust and points won't stay open. Complete sealing causes oil pumping, but partial sealing with vent holes seems to work satisfactorily. Distributors will go from 250 to 1000 hr with proper precautions – about 5 min without.

Finds Substitutes for Aluminum in Brake Pistons

TIN - PLATED cast - iron and tin - plated steel pistons were found to be the best substitutes for aluminum brake cylinder pistons in a series of tests carried out and reported by J. F. Bachman, Chrysler Corp., in his paper on "Substitution for Aluminum in Brake Cylinder Pistons."

A satisfactory substitute material for aluminum must have the required strength, rigidity, ability to resist corrosion, and low rate of wear. It must be easily "wet" by the lubricant in the fluid and have sufficient adhesion to the lubricant to maintain a lubricating film between itself and the cylinder wall. It must not cause sludge to be formed, and it must have good machining properties.

The materials tested by Mr. Bachman included cast iron, both plain and with different coatings, steel of various types, carbon block, a number of different plastics, powdered metal, and rubber-coated steel.

The strength and rigidity of the pistons were determined by using a special fixture in conjunction with a tensile testing machine.

Lubrication, wear, scuffing, corrosion from the fluid, and resistance to sludge formation were determined from a laboratory stroking test and from results obtained on road-test vehicles. The tests on the stroking machine were run at room temperature and at elevated temperatures.

Corrosion time was checked by subjecting the pistons to a standard salt-spray test. Sludge and soap formation tendencies were determined by placing the pistons in a flask of brake fluid, along with samples of all the other materials, including rubber and metal, used in the hydraulic brake system. The specimens were subjected to a temperature of 170 F for 125 hr.

Impact-extruded primary-aluminum pistons were used as the basis of all test work. As the use of this material is restricted for the manufacture of these parts, pistons made of secondary aluminum by the permanent-mold method were tested and approved for production. Brake pistons made of secondary aluminum had been successfully used in production for several years prior to the development of the impact-extruded piston.

Tin-plated cast-iron pistons were found to be the most satisfactory substitute for aluminum pistons.

Tin-plated steel pistons were also found to be satisfactory; however, they present a dfficult handling and inspection problem, as the slightest nick or burr may scratch the cylinder bore and cause a leak.

Of the various plastics tested, Durez No. 1544, with a hardened steel insert, showed the best possibilities; however, more experience is needed before it can be approved as a satisfactory substitute. It is known that satisfactory pistons can be made in the laboratory on a small scale, but whether this material could be used on a production basis is another question.

All the other materials tested proved to be unsatisfactory for one reason or another. For instance, with pistons of powdered metal, difficulties were encountered in sealing the surface, from a corrosion standpoint. Rubber-covered steel pistons showed some possibilities; however, failure of the bond between the rubber and the sides of the steel piston occurred on almost all of the stroking-test samples at from 125,000 to 465,000 cycles.

Turn to p. 33 for excerpts from the final talk given at the meeting sessions, "Looking at the Future Through the Eyes of Research" by C. F. Kettering, General Motors Corp.

Among the Speakers

L. F. Overholt, O. J. Snider, and J. F. Bachman

Progress in Air Service Ends 'Model' Transport

continued from page 42

if a satisfactory utilization factor is to be obtained.

Having thus outlined the basic types of airplanes needed to furnish the kind of service which can be of most benefit to the air traveler, we can now list the principal design criteria and operating requirements most desirable from the airline operator's point of view.

First of all, any transport airplane must be conceived around its passenger cabin and cargo compartment for passenger operation, or its cargo compartment if specifically designed for air cargo service.

Second, every part of the airplane should be designed for utility.

Third, more intelligent thinking must be given to the maintenance and service of various components of transport airplanes.

Fourth, it is felt that a 50-to-60 passenger capacity should, perhaps, be the limit for domestic operation, as highest permissible system speed and frequency of schedule are more important from the traffic viewpoint than capacity.

While it is not within the scope of this presentation to discuss detail specifications we should, nevertheless, point out a few fundamental requirements for future transport airplanes as dictated by past operating experience.

1. Structures: All-metal cantilever structures of smooth-skin construction have been found highly satisfactory and there is no reason why their use should be discontinued.

Wing loadings are still going up and will continue to do so as long as aerodynamic improvements in auxiliary lifting devices for take-off and landing will permit such increase without unduly raising the maximum approach and landing speeds.

2. Powerplant: It is essential that powerplant installations from the firewall forward be made interchangeable.

Powerplant design must be properly coordinated between the engine and airplane designers. It is useless to have a light engine if it results in a heavy installation.

3. Landing gear: While I desire to place no limitation on the type of system used either to extend or to retract the landing gear and also wing flaps, that is, either pneumatically, hydraulically or electrically, Civil Air Regulations dealing with one engine inoperative during take-off clearly indicate the necessity of accomplishing these operations in the shortest time permissible.

It is felt that every new post-war transport should be equipped with tricycle landing gears, for obvious reasons. First of all, the expectation of all-weather landings and take-offs will require the best ground stability possible, especially when negotiating crosswinds. Second, the elimination of the landing flare will permit better landings to be made, particularly in poor visibility. Third, a level attitude is essential for sleeper operation and cargo service.

4. Cockpit: The pilot's cockpit offers a prolific source of improvements. The first item is unquestionably that of lighting.

Rearrangement of controls according to selective functions must receive further thought.

The windshield should be birdproof. Perhaps one of the best solutions for this problem is to design the windshield as a part of the fuselage contour without impairing visibility.

5. Flight Controls: With the exception of limited service and long-range operation airplanes, no automatic pilot need be provided as cargo and local schedule airplanes will be used to a large extent for pilot training, and its elimination from these airplanes will serve to increase their payload and reduce their maintenance cost accordingly.

Automatic pilot installations should be operated from hydraulic pressure derived by a separate pump to insure system cleanliness, eliminate pressure reducing valves, and keep pressure cycles of the main hydraulic system at a minimum.

6. Electrical System: A minimum potential of 24 v should be specified even for the smaller airplanes. With increased functional

Table 1 – Proposed Characteristics for Future Transport Airplanes

	Airplane #1 Feeder	Airplane #2 Local	Airplane #3 Limited	Airplane #4 Long Range	Airplane #5 Cargo
A) General Specifications:					
a. Gross weight, lb	12,000	30,000-35,000	40,000-55,000	75,000+*	50,000-60,000
b. Useful load, lb	4000	10,000-11,500	13,000-18,000	25,000+	25,000-30,000
c. Passenger capacity, day	8 to 10	25 to 30	32 to 40	60+	......
night	......	......	16 to 20	30+	......
d. Cargo capacity, cu ft	100	400 to 450	600 to 750	1000+	2000 cu ft
e. Number of engines	2	2	2 or 4	4**	2
f. Powerplant	Gasoline	Gasoline	Gasoline	Gas. or Diesel	Diesel
g. Power loading, lb per hp	10	12	12 to 14	12 to 14	14
h. Wing arrangement	High Wing	Low Wing	Low Wing	Low Wing	High Wing
i. Flight crew, number	2 Pilots	2 Pilots 1 Cabin Att.	2 Pilots 1 Radio Op. 1 or 2 Cabin Att.	2 Pilots 1 Radio Op. 1 Navig.*** 2 Cabin Att.	2 Pilots 1 Cargo Handler
B) Performance:					
a. Cruising speed 50 to 55% of mph rated hp	150 to 160	200 to 220	240 to 250	250+	200+
b. Stalling speed (flaps in approach position)	50	80	80	90	80
c. Take-off distance to clear 50 ft obstacle	1000 ft	2500 ft	3000 to 3500 ft	4000 to 5000 ft	2800 ft
d. Range plus ¾ hr reserve, miles	300	750	1500	2000+	1500
e. Single engine ceiling	Meet CAA Terrain Requirements				

* Maximum gross weight depending on available engines. Might be flying boats in larger sizes.
** Possible use of powerplant installations from airplanes 2 or 3.
*** May also act as flight engineer.

Highlights . . .

. . . of a talk given before the Detroit Section on May 17, by James C. Zeder, chairman, SAE War Engineering Board:

"THE American automotive industry is producing weapons at so high a rate that even the demagogues have been forced to find other subjects to belabor . . . This engineering war is first fought on drafting boards, in test rooms and laboratories, and over our proving grounds long before the battle . . . Already American engineers are out-researching, out-designing, and out-producing Hitler's slaves, proving the superiority of free men and free enterprise . . .

"The SAE War Engineering Board began its work long before Pearl Harbor, and has brought more than 2000 engineers voluntarily into war service . . . Nowhere else in the world could such a galaxy of engineering talent have been recruited . . .

. . . In a direct action advisory capacity the W.E.B. functions on engineering problems upon request of the Army and other Government agencies . . .

"The wide variety of engineering assignments have helped the nation to meet emergencies created by materials shortages and turning the manufacturing facilities of the country into a vast arsenal . . . High praise has been volunteered by ranking military officers for specific accomplishments . . .

"The SAE-W.E.B. is an example of kinetic patriotism . . . It has put inter-company competition and jealousies on the shelf for the duration . . . It has made all automotive engineering knowledge available for the war program . . .

"W.E.B.'s work on materials conservation and substitution makes it possible to build four tanks instead of three, saved millions of pounds of nickel, copper, chromium, and other metals, and the Army got a better tank . . . Other projects included a manual on design applications of helical and spiral springs for Ordnance, redesigning tools for tanks, reporting on plastics that would stand subzero temperatures, recommending a preferable antifreeze, reporting on lubricants, recommending methods to preserve engines and parts for shipment overseas . . .

"Dustproofing mechanical parts and assemblies is a new task, and scores of other engineering problems are being attacked by the nation's leading experts who are giving so generously of their time and energy . . . Through these pioneering, ditch-digging, fundamental engineering and trouble-shooting jobs the United Nations are getting the technical edge on the Axis – and there lies ultimate victory."

reliability of modern generators and engines, storage batteries become more or less voltage regulators and can be of small capacity as, for air transport operation, an external source of supply is always available for plug-in when the airplane is on the ground.

7. Fire Protection: Adequate fire protection must be provided, not only for the powerplant installation but also for the passenger cabin and cargo compartment.

Vivid Vistas Bid Engineers

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ably reach its highest fruition in the largest type planes where head room for convenience and a maximum of absolute dimension within balancing limits of the center of gravity will be possible.

If we do confound today's experts and break through the speed of sound for regular operation, it will possibly be with the supercharged flying wing squirt type, and then we shall have many new problems as today's classical laws of flow, lift, drag, center of pressure travel and other air force characteristics will no longer apply, and such planes will have to be designed to land and take off safely as conventional types and still fly safely at supersonic speeds.

The Sikorsky helicopter, and its dramatic demonstrations recently in stability and control, brings attention anew to the rotating lift field. Both military development and post-war opportunity have caused many companies to give that field close attention. The rotating lift field seems best suited for the small private owner and similar activities.

Glider System

Another development which should offer great promise is the glider pickup and discharge system.

A tremendous development which was just beginning in the late 30's and now is almost entirely absorbed by the military, but which will be returned to aviation commerce much enriched, is the whole field of electronics, including communication and indication, such as radar.

Powerplant improvement is another phase of aviation which is going forward apace these days.

Progress has created another problem which engineering must consider. It involves assisted take-off acceleration and perhaps landing acceleration. We are constantly running wing loadings higher and higher, but airports can't grow much more in size than some of the bigger ones are today. So either wing loadings will have to stop or assisted take-off by gravity, catapult, rocket or other device will have to be developed.

I have mentioned only a few of the engineering thresholds available today. Some are conventional and some are distinctly not. There are many more in both the conventional and unconventional classes, too numerous to mention. Let us try to see what these thresholds may lead to within a decade.

First, we shall have a nation and a world which will owe its freedom to air power. Security in the future will be synonymous with the dominance of air power. We shall also have in the peace many, many airfields never before in existence, which have been built to feed this machine of

war and then will be available to commerce.

Aviation should then take its proper place in the transportation and private travel picture. I have always deplored the belief that aviation will replace other forms of transport. I do not believe this will be true. Even with these thresholds larger than ever before, I doubt whether aviation will ever touch nine-tenths of the transportation now carried by rail, road and water. Each form of transportation has its particular utility and even by the greatest stretch of the imagination it is not possible to picture aviation performing all of the functions now divided among the several modes of transportation. Aviation has its purpose quite definitely defined. Among other things, it will create new opportunities for trade and stimulate new desires to travel. Aviation will simply supplement and in turn be supplemented by the rest of the vast transportation system we are to enjoy after this war.

Discussion of Damon paper

"He has left us with many thoughts to stimulate our imagination," said Arthur Nutt, Wright Aeronautical Corp., "and aviation *will be available* to many if the development can be accelerated and brought to the point where the airplane can supplement other forms of travel. The most popular conception of the use of aviation is by the private airplane, and for the first time in aviation's history, the hovering type of ship, even in its present form, opens up a very attractive means of air travel for trips of 100 to 300 miles in length."

Charles Froesch, of Eastern Air Lines, looking at the future of aviation from a world-wide angle, feels that . . . "international air commerce can only grow to its rightful place if all nations will grant to each other the right of innocent commercial flight with specific refueling points consistent with the national security and sovereignty of each nation and their trade.

"It certainly would be economically impossible to design a transport airplane to carry fuel half-way around the world without stopping at intermediate points."

Regarding Mr. Damon's statement that aviation speeds will increase to close to 400 mph within the next 10 years, William Littlewood, American Airlines, Inc., pointed out that the incentive to increase speeds increases with range, and the economy penalties of high speed decrease with range because of the corresponding increase in flight efficiency and in justifiable premium. We may well expect speeds of the order mentioned by Mr. Damon in long-range travel, but other factors of performance, utility and economy are so important in the short-range field that substantial increases over present practices are not indicated.

"It is pleasing to hear the predictions of the speeds of future airline aircraft made by a man as practical minded as Mr. Damon," stated William K. Ebel, Glenn L. Martin Co. "I have no reason to doubt that all of these performances that he has predicted will be made. However," he continued, "they appear to me to be relatively in the class with the speeds of the Queen Mary, Normandie and the Santa Fé Super-Chief. They are fine for a relatively small fraction of the business. The great bulk of air cargo will still be carried by aircraft of lesser performance."

"Air transportation is now developing into three major types of operation," reported A. A. Priester, Pan-American Airways. First, long range, with flights of 2000 miles and upward; second, medium range, with flights of between 1000 and 2000 miles; and third, short range, with flights of less than 1000 miles. To attain maximum operating efficiency in each type of operation, airplanes should be designed specifically for each type of operation. It is also probable that airplanes will be designed for exclusive passenger and mail service; mixed passenger, mail and freight service; and exclusive mail and freight service. It all depends on the density of commerce on each route, as to which type of airplanes can be best adapted for that route.

America's famous half-tracks, mounting hard-slugging cannons, are cracking down on enemy tanks on our fighting fronts.

Yes, war reports tell us they got off to a fast start. And behind that fast start is the "BENDIX" Drive. Long known for its peacetime record of billions of swift starts, the "BENDIX" Drive is winning even greater renown today serving with our Armed Forces. As original or replacement units, the "BENDIX" Drive is starting something on every front.

The "BENDIX" Drive is a vital member of "The Invisible Crew" — the precision equipment built by 25 Bendix plants from coast to coast and serving with our fighting crews on every front.

THE INVISIBLE CREW
Precision Equipment by
Bendix
AVIATION CORPORATION

ECLIPSE MACHINE DIVISION

Iron Extraction Now Reaching High Peak

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metallic iron in a spongy condition ready to become molten in the lower part of the furnace or hearth. The waste gases continue up through the furnace and escape through openings in the top to continue their processing through the auxiliary equipment for reclamation. This process is continuous, and is accompanied by a periodic removal of a

part of the impurities in the form of slag at an opening between the tuyères and the bottom of the furnace and by a like removal of metallic iron through a larger opening at the bottom.

Therefore, the furnace divides itself into three important zones: (1) Drying zone; (2) reducing zone; (3) fusion zone.

The first change that takes place is the physical one of drying. The stock (iron ore, limestone, coke) with its interstitial spaces filled with the ascending gases, mainly carbon monoxide and carbon dioxide, starts to descend toward the bottom of the furnace into regions of higher and higher temperature. At different levels, chemical reactions peculiar to the temperatures of these levels will occur. Even at the lower temperatures, the iron oxide is beginning to be reduced to metallic iron. After the mass descends to near the tuyères it consists of a mixture of gangue, quicklime, coke and spongy metallic iron. At the fusion zone (about 2900 F) the gangue and quicklime and other foreign materials combine to form a molten slag.

This slag and the iron, both of which are in the molten state, trickle down through the interstices of the coke to the hearth, where they become separated by gravity, forming two layers – one lower or metallic layer containing all reduced substances, and an upper or slag layer containing all foreign or unreduced matter. At the proper time, the iron notch or hole which is located in the bottom of the hearth is opened and the iron is cast in the molten state. The slag which is on top of the molten metal in the hearth is also tapped through a cinder notch located in a higher position in the hearth. To make one ton of molten iron it requires approximately two tons of iron ore, one-half ton of limestone, and four tons of air.

It is the abundance of iron in the earth which is the chief cause of its cheapness, and therefore one reason why it is used more than any other manufactured material. The other reason is the ease with which one can confer upon it at will some of the qualities most useful to man, of which the most valuable is probably its strength, and the most wonderful its magnetism.

Higher Pressure Results in Lower Tubing Weight

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amount of work to be done. With a reduction in area, the weight of the cylinder will naturally decrease. With increase in pressure, the wall thickness of a cylinder will not necessarily increase as the wall thickness on low pressure cylinders is already to a minimum due not to the stresses in the material but to the impracticability of machining the wall any thinner. On high pressure cylinders the wall thickness usually falls within the D/t ratio of 40, which we consider to be the maximum ratio for satisfactory machinability.

Time element involved in the operation of certain units is quite critical. It is considered by most pilots advantageous to be able to retract the landing gear within 10 sec after the time the wheels leave the ground. This is usually the predominant factor in determining the size and capacity of the hydraulic system to be installed.

At first, on high-pressure systems, some difficulty was encountered in preventing line leakage. This was due to improper tightening of line fittings as the installation crews had been cautioned against over-tightening of fittings on aluminum alloy lines used in the low pressure systems, but when high pressure systems were introduced, ¼ hard stainless tubing and steel fittings were used, which were capable of withstanding torque loads considerably higher than the low-pressure fittings.

It is, of course, not necessary to operate all the units at high pressure; reducing valves may be used to reduce the pressure for units not requiring high pressure such as brakes and surface control boosters.

Prop Selection Early Requirement

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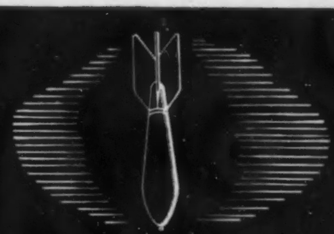
consideration of structural loads, and full responsibility for the strength of the propeller lies with him. An appreciation of the problems involved is, however, helpful in an airplane organization to avoid extensive investigations of propellers that might be aerodynamically suitable, but are structurally not acceptable for the required installation. In most cases, it is impractical



Who Wins Wars?

Strangely enough, the average man does! Much as we all detest war the fact is that under its stimulation a nation always develops new products with infinite peacetime applications. To date, scores of fantastic devices have been created for war purposes which one day will contribute mightily to the American Way of Life. Weatherhead is producing at the rate of *millions every day* many products that have peacetime application. Just as we've helped build cars, planes and refrigerators in the past, Weatherhead is well prepared to help you build these new products of tomorrow.

Look Ahead with

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THE WEATHERHEAD COMPANY, CLEVELAND, OHIO

Manufacturers of vital parts for the automotive, aviation, refrigeration and other key industries.

Plants: Cleveland, Columbia City, Ind., Los Angeles
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to assign ratings for propeller speed and power to be used as a final guide for the airplane designer, and the direct assistance of the propeller manufacturer is necessary.

In the foregoing list, there are other items that are of more direct and active interest to the airplane designer. The most obvious of these are the propeller performance, its weight and size, and its installation requirements. In general, the consideration of at least these items should be the subject of intensive cooperation.

A careful propeller selection analysis is ultimately desirable for every airplane to insure the use of the best available equipment, but since an analysis to include every possible blade and hub can be burdensome, some general considerations on the type of propeller to be used will be helpful. It is often possible to decide in advance of detail studies whether the airplane should have single or dual rotation propellers, a three-blade propeller with wide blades or a four-blade propeller with narrow blades.

On the question of the best number of blades, it should be recalled that while the theoretically best propeller has an infinite number of infinitely narrow blades, the practical performance differences among propellers with varying numbers of blades providing the same total blade area are very small, and the effect on weight within the limits of present experience is usually small enough to be masked by other influences. In general, therefore, a three-blade propeller should be chosen instead of a four blader when designs offering comparable blade areas are available. The three-blader will be cheaper to build, cheaper to maintain in service, and less likely to encounter vibration problems.

A propeller having a greater number of blades than another is actually desirable only when the propeller operating forces that result from the use of excessively wide blades become too great to be handled in a practical manner. This point can best be determined by the manufacturer of the particular type of propeller under consideration. In the evaluation of this problem for dual rotation propellers, the same general considerations will apply.

As a part of the propeller selection problem, the propeller installation requirements should be considered in a general way, and early in the detail design of the airplane, the propeller installation should be thoroughly covered along with the other components of the powerplant. A review of the installation with the propeller manufacturer will be helpful, if undertaken before the details are frozen.

Provision for installation of the propeller itself raises a question of dimensional requirements. Clearance for the propeller diameter is, of course, fundamental. Provision of clearance between the propeller and the adjacent engine cowling is not difficult if properly studied fairly early in the airplane design, when aerodynamic studies for the engine cowling arrangement are in progress. In some cases, the provision of the desired cowl outline may conflict with the location of the propeller blade trailing edge in the feathered condition.

The solution of the problem is, however, one of simple arithmetic, and should at most have no more serious effects than to introduce into the original propeller selection an additional element for consideration. In the choice between blades with wide and narrow shanks, clearances should be considered, particularly when the installation involves a relatively short coupled engine where provision of a good cowl nose between the maximum engine diameter at the cylinders and the propeller blade trailing edge is difficult.

The installation of non-feathering propellers for single-engine airplanes differs in the case of the Hydromatic by omission of the feathering pump, with its controls, wiring and plumbing. The propeller itself, the constant-speed control unit and the cockpit control are normally all that are required. The problems encountered are analogous to those for any normal control linkage and need no special precautions.

Steel Ordering Requires User-Mill Cooperation

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they must be of such characteristics that they will aid the furnace men to obtain better control and produce more-uniform quality steel. Steel quality means that the customer is not only obtaining a steel that will make the part, but that the steel producer is able consistently to supply uni-

form properties throughout each heat and from one heat to another.

In recent years, the metallurgist has come into his own, and these trained men have filtered out into the consuming end, where today almost all grades of steel have been tied down to very definite specifications and binding requirements.

It would be too much in this short paper to go into the various grades of steel, as there are as many combinations of analyses as there are stars in the sky, and they all have their particular reason to exist.

Mill Needs Details

It is very essential that when a customer wants steel, he should give all the *detailed* information at his command concerning the analysis, physical properties, and how the material is to be used, description of the part, as well as the forming operations involved. It is only through close control between customer and producer that he gets satisfactory steel and remains satisfied.

From an open-hearth standpoint and let's talk about the Kaiser open-hearth shop, as I believe it will be, without a doubt, the most modern one in the country:

The first thing that strikes my mind is the design. Our shop is laid out with plenty of room, with all materials and equipment strategically placed for efficient operation. The next thing is the control and design of the furnace itself. Such things as forced draft, venturi ports, and automatic control are in the operator's power to use as he sees fit to do a real melting and refining job.

Process Under Test

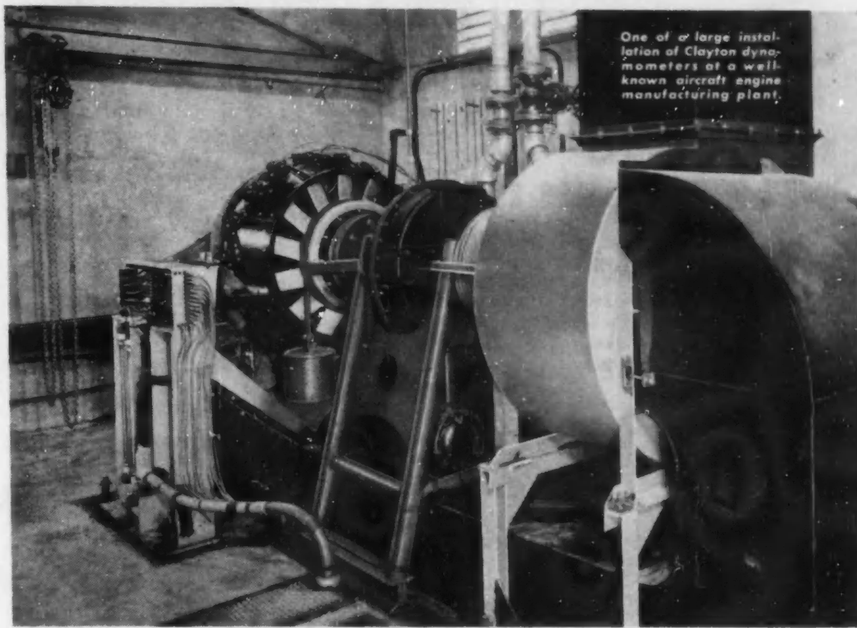
Jumping to the metallurgical end, I should point out that trained metallurgical observers follow our entire open-hearth process, checking, recording, and seeing that standard procedures are followed. He is assisted by a control, which follows on back to the metallurgical laboratory. Here, under a trained and skilled metallurgical atmosphere, your steel is etch tested for internal soundness, looked at on a modern microscope for microscopic defects such as dirt and grain size. Magnifications of the defect reach 10,000 times their original size. It may be put through a rigid physical or chemical testing procedure or given a hardenability processing that would tell them how it would react to the customer's processing. After it has made the processing circuit, and by testing it is certain, to the best of our knowledge, that nothing inferior is present, it is released for shipment.

Even with this rigid control, it is impossible to say that the steel will perform 100%, since we cannot test every little section of the steel nor can every little detail be covered, as there are variations that creep into the customer's processing that may alter the picture completely.

turn to page 74 for News of Society

SAE Post Office Key Number is 18

The post office key number for SAE headquarters in New York is "18," and it should be used as follows in addressing mail;
Society of Automotive Engineers, Inc.
29 West 39th Street,
New York 18, N. Y.



One of a large installation of Clayton dynamometers at a well-known aircraft engine manufacturing plant.

"We're testing engines with WATER NOW!"

When a new or replacement engine is put in a combat plane, ship, or truck—its unquestioned performance must be guaranteed.

This requires that the engine be tested under load, with the power output accurately measured throughout its entire performance range, *before installation.*

War has accentuated the need for simplified dynamometer engine testing equipment which could be readily produced from a minimum of critical materials to meet both laboratory research and production testing requirements.

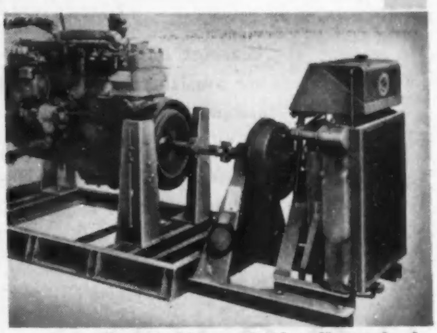
CLAYTON HYDRAULIC DYNAMOMETERS FILL THIS IMPORTANT NEED

Based on an entirely new way of hydraulically loading an engine, the exclusive Clayton developed "closed hydraulic system" insures the ability to hold any load constantly.

Clayton Dynamometers are lower in cost; require a minimum of technical skill for operation and maintenance—yet they provide the accuracy of finest laboratory instruments.

The Clayton line ranges from simplified run-in stands to dynamometers with full instrumentation, 50 to 3000 hp—and make dynamometer testing practical and available for the production or servicing of all types of aviation, automotive and marine engines.

Other Clayton products serving the Armed Forces are Kerrick Kleaners... Kerrick Cleaning Kompounds... Clayton Steam Generators... Clayton Boring Bar Holders and Clayton Hydraulic Liquid Control Valves.



Illustrated is completely self-contained automotive engine run-in and test stand used at Army overhaul bases.

CLAYTON MANUFACTURING CO.

ARMY E NAVY

ALHAMBRA CALIFORNIA

News of the Society

Rough Roads Harm Cars, Declares W.E.B. Report

The need for keeping roads and highways in good condition, and, where that is not practical because of wartime shortages, the importance of encouraging operators to drive with discretion, to maintain correct tire pressures, to avoid overloading, and to have vehicles and tires checked at frequent intervals so that the damage done by rough roads may be corrected, are fully demonstrated in a report entitled "Effect of Holes and Ruts in Highway Pavements on Tire Life," made by the SAE War Engineering Board to the Automotive Council for War Production.

Deep holes and ruts in highways drastically reduce the life of tires and other parts, and may even result in immediate failures, the report concludes.

The following factors are listed as having a bearing on the adverse effects of rough roads:

1. Where there are many holes in the road, the efforts of the driver to avoid them increase tire wear – in much the same way as driving continually on curves. The weight of the vehicle is shifted from one side to the other, and, with dual tire equipment, from one tire to the other.

2. In trying to avoid the holes, the driver accelerates and uses his brakes more frequently – rapidly wearing down the tires.

3. Defective road shoulders are hard on tires, as the tires may be damaged by the hard edge of the pavement when they are driven back on it after a drop-off. With dual tires, the inner tire may carry all the load for short periods, with the outer tire hanging unsupported in the air.

4. The effects of defects are augmented by underinflation and overloading. Underinflated tires are more susceptible to bruising, and the more severe flexing to which rough roads subject the tires increases internal heating – an important factor in the hot summer months. The consequences of overloading are similar to those of underinflation.

5. The fact that the proportion of relatively old tires now in service is high will tend to accentuate the effects of rough roads on tire life. Older tires are more susceptible to breakage by bruising, and the decreased tread thickness on old tires affords less protection against impact.

6. Rough roads can have serious effects on the vehicles themselves, as the forces transmitted to the vehicle may be of considerable magnitude. The repetitive nature of these impact forces tends to produce fatigue failures of suspension parts, such as axle shafts and springs. These conditions are bound to lead to an increase in maintenance in areas where previously smooth highways have become rough.

7. When the forces on the vehicle do not cause actual failure, they may give rise to bending and distortion, which may in turn lead to misalignment of the front wheels – another cause of rapid tire wear.

W.E.B. Report Outlines Test for Used Antifreeze

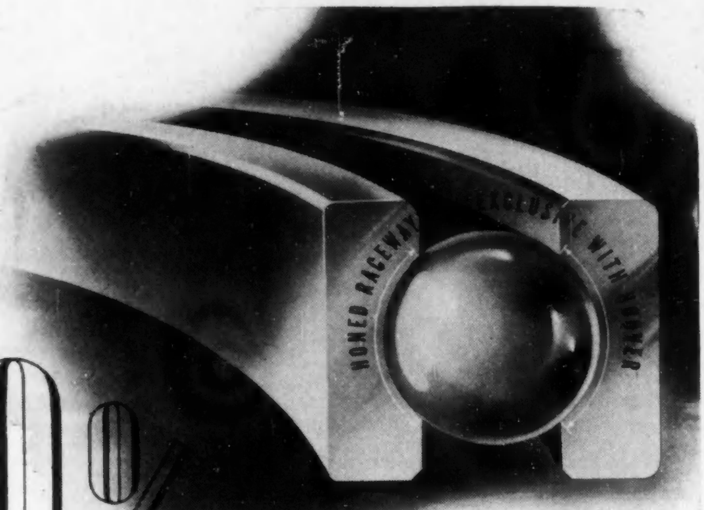
Practical procedures for conservation of antifreeze solutions are recommended in a recent SAE War Engineering Board report to the War Production Board.

The antifreeze should be saved, the W.E.B. suggests, only if it can pass certain tests, because the continued use of solutions that are corrosive may be extremely harmful. In the absence of any special recommendations from the antifreeze or vehicle manufacturers, the following procedure is suggested by the W.E.B. to reduce to a minimum the hazards of corrosion, rust-clogging, overheating, and freeze-up:

1. Determine if the antifreeze solution is one of the recommended types: alcohol or ethylene glycol. If it is of the deleterious salt or oil type, it should be drained and discarded immediately, and the cooling system thoroughly cleaned.

2. Check the solution with a suitable antifreeze tester, and record the temperature to which it is protected. Very weak solutions may not be worth saving.

3. Preserve the solution in a satisfactory manner by draining and storing it. If it is of the ethylene glycol type, it may be desirable to leave it in the system to avoid



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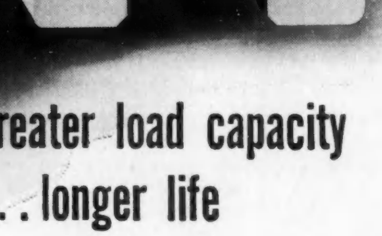

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e possibility of drainage losses. Solutions ould be checked in accordance with either the following tests:

a. Dip blue litmus paper in the solution. the paper does not turn a distinct pink red, the solution is suitable for further e.

b. Allow a sample to stand in a glass ntainer for a few hours. If the solution comes clear or has a slight tinge of the olor of the original solution, it can be ed again.

If the blue litmus paper turns a distinct nk or red, or if the solution, on standing, es not clear up, it should be discarded.

4. Before the stored solution is returned use, it should be tested again for antieeze strength. If it is necessary to inease the freezing protection, fresh marial, preferably of the same brand, should e added.

5. When ethylene glycol antifreeze is ed for more than one winter, it should eceive more than normal inspection and st. A special reinhibitor, recommended y the manufacturer of the antifreeze used n the car, should be used. Other inhibitors, egardless of their suitability for other purposes, will prove unsatisfactory.

6. The mixing of different brands of ntifreeze in the cooling system should be imited to those having the same basic marial, such as ethylene glycol or alcohol. Mixtures of ethylene glycol and alcohol annot be tested with a commercial antireeze tester.

E. H. Smith, Packard Motor Car Co., s sponsor and W. H. Graves, Packard Motor Car Co., is chairman of the committee that drew up this report. Other members of the committee are: E. W. Upham and J. D. Klinger, Chrysler Corp.; H. C. Mougey, General Motors Corp.; J. L. McCloud, Ford Motor Co.; D. H. Green and J. K. Seydler, National Carbon Co.; H. C. Duus and E. H. Keller, E. I. duPont de Nemours.

Liaison Established between W.E.B. and T&M Groups

Regular liaison in regard to subjects of mutual interest has been established between the SAE War Engineering Board and the SAE-T&M Ordnance Vehicle Maintenance Committee. Liaison representatives have been appointed from both organizations to correlate any activities where joint interest exists.

L. R. Buckendale, Timken-Detroit Axle Co., has been appointed to represent W.E.B., and Donald K. Wilson, N. Y. Power & Light Corp, to represent the T&M group.

Critical Materials Studied by TWEC

Conservation of critical alloy steel, rubber, and copper was emphasized at the Tractor War Emergency Committee meeting held in Chicago on June 4.

In the absence of O. R. Schoenrock, chairman of the Alloy-Steel Subcommittee, George Jorgenson, J. I. Case Co., reported on the important work this committee is doing.

As evidence of the substantial progress already made by the tractor industry in alloy-steel simplification, Mr. Jorgenson revealed that in recent months the list of alloy steels has been pared from over 80 to 17, and most of these 17 are NE steels. One of the largest tractor companies, he reported, now specifies only two alloys – both in the NE 9400 series. The TWEC and its Alloy-Steel Subcommittee, he said, have contributed heavily to this accomplishment.

Further progress in the substitution of NE steels containing a minimum amount of critical alloying elements for SAE steels or other NE steels is expected after the recommendations made in the latest progress report of the Subcommittee are discussed in meetings and adopted by the industry.

The continued interest of WPB in Bessemer steel led TWEC Chairman A. W. Lavers to suggest that the Alloy-Steel Subcommittee study the present and possible uses and available supply of Bessemer steel and re-rolled rails.

The tire and rim simplification program is continuing, according to the report of E. F. Brunner, Goodyear Tire & Rubber Co., acting as consultant for the Office of Rubber Director. A simplified list of permissible tire sizes for 1944 farm vehicles has been completed. It has been turned over to the WPB as a recommended list of permissible sizes. A similar project is under way for

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the simplification and standardization of rims for tractors and implements.

In view of recent developments that have been made in radiators that show promise of savings in critical materials, particularly copper, L. S. Pfost, Massey-Harris Co., was appointed chairman of a subcommittee to investigate the matter.

SAE Is to Assist CAC On Technical Problems

Procedures for SAE assistance to the Central Aircraft Council (recently organized at the request of Army Air Forces officials in the Middle West area) were clarified when the CAC steering committee on May 7 decided that:

The CAC appoint a CAC Engineering Policy Committee to handle matters pertaining to policy; that this committee stand ready to work with and parallel the engineering committee set-up of the East and West Coast Aircraft Councils; that matters requiring technical research and investigation be referred to the SAE War Engineering Board for action; and that the SAE-W.E.B. report its findings on matters referred to it directly to the CAC Engineering Policy Committee.

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Section Round-Up

continued from page 44

Oregon ... Oregon State College stude who submitted papers on subjects th wanted to present before the SAE recei checks for $18.75, for purchase of bonds if they wish. "Liquid Hydrogen" described and demonstrated by Earl Fly Air Reduction Sales Co., at this May meeting. George Higgs, S. P. & S. R. spoke on "Supercharging of Heavy-D Diesel Engines."

Philadelphia ... There were two s jects for the meeting at the Engineers' C on May 12—"Radio Goes to War" at t dinner meeting, and "Farm Chemurgy" the evening session.

Pittsburgh ... George A. Round, co sultant on fuels and lubricants for the Fu and Lubricants Section Technical Divisio Office of the Chief of Ordnance, discusse fuels and lubricants for the U. S. Arm Motorized Ground Forces on May 25.

St. Louis ... "The Scorched Earth Poli in the Dutch East Indies" was presented o May 25 by W. H. Montgomery, who, un a short time before the Japanese invade the Dutch East Indies, was assistant gener manager of the Standard Vacuum Oil Co. refinery at Palembang, Sumatra. He de scribed the destruction of this large plan

Southern California ... Wallace E Brainard, supervisor of Tool Operation Plan ning for Consolidated-Vultee Aircraft Corp discussed tool and operation planning in re lation to engineering and manufacturing.

Texas ... Application of knowledge, no politics, will solve future problems in avia tion, William B. Stout, whose Dearborn Mich., laboratories are now functioning i the Consolidated-Vultee Aircraft Corp. or ganization, said in addressing the annua meeting of the SAE Texas Section. Th meeting was a feature of the Second Annua Texas Aviation Conference held in May.

Washington ... Major William A Walsh, Field Service Division, Office o Chief of Ordnance, told members and guest at the May 17 meeting about his experience in Australia.

Colorado ... Dan J. McQuaid, discov erer of the Air-Vu System of drawing, and inventor of the Sun-Vu Projection Drawing Machine, was guest speaker on May 11.

Mohawk-Hudson ... Thirty-one mem bers of the Group met in Schenectady to view two films—one called "Only An In formed America Is An Invincible America," and the other a color film of Igor Sikorsky's helicopter. The pictures were shown at Union College and the Group then retired to a nearby restaurant to enjoy beer and sandwiches.

Muskegon ... Darwin Peterson, Peterson Radio Co., Muskegon, Mich., was main speaker at the May 7 meeting. The subject of his speech was electrons.

Peoria ... On May 31 the group presented Dr. L. A. Blanc, Dr. E. Landen, C. R. Maxwell, and J. E. Jackson speaking on "Diesel Engine Combustion Research." This discussion covered work done jointly by the Caterpillar Tractor Co. and the Armour Research Foundation.

About SAE Members

continued from page 49

ormerly coordinator of manufacturing, Aircraft Corp., Marietta Aircraft Asbly Plant, Marietta, Ga., **MAX STUPAR** been made manager of the Georgia ision of the company.

OBERT T. GOFFIN, who had been cess engineer for the Sterling Engine Buffalo, N. Y., has joined the Sperry roscope Co., Inc., Great Neck, L. I., Y., as senior methods engineer.

WILLIAM H. WHITE, JR. has entered U. S. Army. In civilian life he was a earch engineering assistant, Vega Airft Corp., Burbank, Calif.

JOSEPH P. ZIMMERLE is factory repretative for the Packard Motor Car Co., troit. Mr. Zimmerle had been director quality, Foote Bros. Gear & Machine Co., icago.

Formerly design engineer, Stinson Airft Division, Consolidated-Vultee Aircraft rp., Wayne, Mich., **ALEX L. HAYNES** lds a similar position in the Aircraft velopment Section, General Motors Corp., troit.

RUDOLPH E. KRUEGER is assistant ject engineer for Avion, Inc., Los Ange-, Calif. Before joining Avion, Mr. rueger was fuselage group leader at Vultee rcraft, Vultee Field, Calif.

PAUL E. HOVGARD recently resigned chief designer of the Glenn L. Martin . to join the Curtiss-Wright Corp., Airane Division, Buffalo, N. Y., as technical sistant to the director of engineering.

HUGH S. ROBINSON is now serving in e U. S. Navy. He had been an engineer the Direct Fuel Injection Department of endix Products Division, Bendix Aviation orp., South Bend, Ind.

CARL H. STEILING is a lieutenant in e U. S. Navy, Bureau of Ships, Washgton, D. C. Lt. Steiling was formerly an gineer in the Utilities Department, Anuser-Busch, Inc., St. Louis, Mo., and also sistant supervisor of shipbuilding, U. S. avy, Missouri Shipbuilding Corp., Lemay, o.

T. F. BRUDENELL is now connected ith the Caterpillar Military Engine Co., ecatur, Ill., as assistant design engineer. e had been chief draftsman of Witte Enne Works, Kansas City, Mo.

O. J. DYSTERUD has joined the Diamond T. Motor Car Co., Chicago, Ill., as spection engineer. Mr. Dysterud formerly eld the position of engineer at the Federale Moon Truck Co., of the same city.

Formerly a student at the Aeronautical Industries Techical Institute, **GLENN L. NAUGLE** is now with the Fairchild Aircraft Division of the Fairchild Airplane & Engine Corp., Hagerstown, Md., as detail draftsman and product engineer.

S. R. MILBURN has left the Goodrich Silvertown Stores Division of B. F. Goodrich Co., Newark, N. J., to join the William Bal Corp., of the same city, as sales manager.

Formerly research assistant, Engineering Experimental Station, Penn State College, State College, Pa., **LIDIA ANSON** is now research engineer, Clark Bros., Inc., Olean, N. Y.

WILLIAM CHALKLEY has been promoted from lieutenant to captain. He can be reached through Headquarters 1st Armored Corps, A. P. O. 758, Postmaster, New York.

NEW MEMBERS Qualified

These applicants who have qualified for admission to the Society have been welcomed into membership between May 10, 1943, and June 10, 1943.

The various grades of membership are indicated by: (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate Member; (SM) Service Member; (FM) Foreign Member.

Baltimore Section: Lt.-Col. John M. Henderson, Jr. (S M), H. D. Neighbours (A), Charles Edward Snyder (A), Henry von Seggern (M), 1st Lt. Claude Carlos White (S M).

Buffalo Section: George J. Farrell (J), John F. Peacock (J), Dean Cullen Sm (M), Harold F. Suthers (M).

Canadian Section: James Masson B (A), Flight Lt. Edgar Parsons Bridgland (George M. Hobart (A), Melville J. K (A), Peter Jack Kinnear (J), John C. M Guire (A), John P. McNair (A), John Symons (A), W. H. White (A).

Chicago Section: G. Douglas Clou (M), Constantine N. Guerasimoff (M), Ra mond D. Mains (A), Wilfred Dale Merrim (J), Richard Wentworth Wilson (J), Ha Zack (A).

Cleveland Section: Paul A. Anders (M), Arthur W. Bull (J), Charles R. Cher (J), William S. Coleman (M), Eugene N son Doubrava (J), Michael J. Duffy (A Joseph A. Frischmann (A), Harley W. H ris (A), Bernard J. Isabella (J), Russel Keller (M), Edwin Bernard Krause (A Henry McKeen, Jr. (J), A. L. Mercer (A George L. Moore (M), Wilber C. Nordstr (J), Paul O. Pfeiffer (J), John W. F. R (A), D. K. Sloteman (M), Virgil C. Spe (J), Harley John Urbach (M), George D Wilton Webber (M), William Mason W liams (M).

Detroit Section: Bertil Torvald A dren (J), J. Alfred Bagnall (A), George E ward Binkelman (A), Reginald F. Broqu (M), Earl A. Burns (M), Edward C. Cl (A), Lt.-Col. Joseph M. Colby (S M), Jo P. Cole (A), John Edward Connor (A), Vi cent Daniel Corrado (J), Thomas B. D Jr. (A), Harry A. Engman (A), Hugo Fries (A), Jack D. Fuller (J), Paul E. Ge (M), Earl George Goetsch (J), Walter Hagen (J), William M. Hawkins, Jr. (M Elmer E. Johnson (J), Venable Dunningt Johnson (J), Harry L. Keller (M), Sc Kennedy (M), Louis C. Lundstrom (J Edwin Carl Maki (J), James William Ma tin (A), A. N. Maskill (M), Harold N Metzel (M), Davison Obenauer (J), Walt Fred Patenge (A), L. W. Penniman (A Keith L. Pfundstein (J), Sidney Potting (J), Hubert C. Reynolds, (A), Bernard El jah Ricks (J), John D. Riggs (A), Jam Rinehart (J), A. A. Shantz (M), Charles C Shepherd (J), Robert T. Skinner (A), Wi liam Leonard Smelt (A), Wendell Sincla Smith, (A), William Henry Smith (A Earl M. Spohn (A), Elmer H. Spring (J Harry L. Stadt (A), Walter Edward Straesse (M), William J. Ulrich (A), J. J. Wallbillic (M), Frederick C. Walther (M), John F Wandersee (M), Charles S. Ward (A), Wal ter L. Weiss (M), Richard W. Winslow (J Paul Wilson Wyckoff (J).

Indiana Section: John F. Gordon (M) Maurice Allen Newman (A), James R Wimborough (J).

Metropolitan Section: John Joseph Ambrogio (J), C. L. William Bailes (A), Robert C. Barth (J), Albert E. Brenneman (M), Elmer F. DeTiere, Jr. (J), Fred C Glasier (A), Harry S. Gould (A), Charle W. Hammond (J), Harry Hanser (A), Walter M. Jordon (J), Irving E. Lightbown (M), Arthur Norris Lillenas (J), Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc. (Aff.) Reps: John V. Bassett, David J. Bonawit, John H. Matthews, Clarence P. Schneider, Albert Whitelaw. J. Bruce McElhone (A), Henry F. McInerney, Jr. (J), George F. Nordenholt (M), Gilbert A. Putnam (M), Anthony J. Slama (A), Paul E. Sotak (A), Alverd Chaney Stutson (A), Milan Andrew

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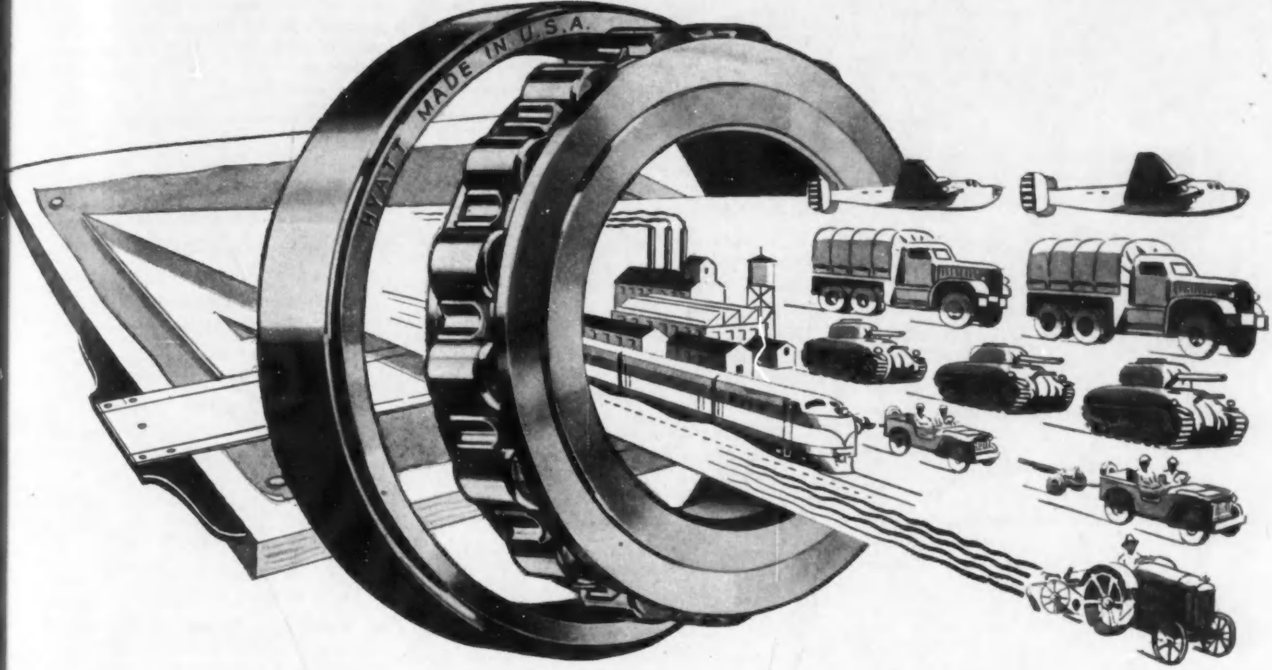

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Milwaukee Section: George W. Iverson (A), Henry C. Osterkamp (M), Ralph L. Perlewitz (J).

Mohawk-Hudson Group: Lester Anthony (M).

Muskegon Club: C. F. Agerstrand (M).

New England Section: 1st Lt. John Kandarian (A), James D. O'Neil (J).

Northern California Section: John F. Durrett (A), Harry Fleharty (A), Henry Milton Hirvo (A), Lawrence G. Klingbeil (A), Alvin John Koster (A), Laurence Levern Moore (M), William G. Nostrand (M), James A. Ransford (A), Leon H. Sandefur (A), W. H. Stellwagen (J), Lt. Paul H. Verd (S M).

Northwest Section: Walter Anderson (A), Jean D. Barnes (A), Sterling R. Dickey (A), George Albert Jackman (A).

Oregon Section: Joy E. Badley (M), A. W. Sheasly (A).

Philadelphia Section: Harry D. Blackburn (A), Wilbur T. Duncan, Jr. (J), Chester W. Engel (M), Max Essl (M), Albert E. Gibson (M), Karl Anton Mertz (J), Joseph W. Parkin, Jr. (A), Harold C. Riggs (M).

Pittsburgh Section: Edward Feigenbaum (A).

St. Louis Section: Walter C. Knoebel (M), V. E. Yust (J).

Southern California Section: Stanford V. Burberick (J), Frank Thomas Collins (J), Raymond L. Fitch (M), Andy R. Gabbert (A), Gabriel Maria Giannini (M), Charles A. Goughnour (A), Robert L. Gunter (M), H. L. Harvill (M), Paul R. Jordan (A), (Miss) Raydelle I. Josephson (J). James L. Kinsel (A), Marvin W Kohlmann (J), W. J. Lockett (A), Tom B. Linton (M), Raymond I. Mahan (M), Ralph E. Middleton (M), Al W. Miller (A), Obert B. Olson (M), Paul H. Ressler (A), Earl A. Sargent (A), E. V. Sundt (M), William Harris White, Jr. (J), Gerald J. Zilz (J).

Southern New England Section: Charles F. J. Buder (J), Howard F. Burbank (J), Steven George Dzielinski (J), Frank Desmond St. Hilaire (A), Leslie C. Small, Jr. (J).

Southern Ohio Section: James K. Balzhiser (J), Lt. T. W. Howard, Jr. (J), William R. Kennedy, Jr. (J), Harold C. Wolfe (A), Nicholas W. Zelenewych (J).

Texas Section: Thomas S. Ashley (A), 1st Lt. Clarence G. Dewey (A), Capt. Robert W. Jenkins (J), Miles Anthony Joanen (A), Don M. Marshall (A), Leon Stephen May (A), Fred R. Muerdter (A), Eli Shapiro (M), Howard N. Smith (A), Wilbur R. Vester (J).

Twin City Group: J. B. McFail (A), C. W. Onan (M).

Washington Section: Lt. Anderson Gordon Bartlett (S M), Jay Besore (A), John W. Cook (M), Lt. (jg) Donald Colin Howarth (J), Wilfred A. Smith (A).

Wichita Section: Harold Jackson Bales (J), John J. Clark (M), Harold T. Johnson (A).

Outside of Section Territory: Frank M. Auld (J), A. E. Hageboeck (A), Herbert N. Hagglund (A), Carl N. Hazlewood (M), Ralph M. Humphreville (A), Robert B. Ingram (J), Joseph Harry Jeavons (A), Robert Taylor Mills (A), Carl O. Monroe (J), James R. Muenger (J), Howard J. Richards (M), Ensign Thomas B. Sharar, Jr. (J), Robert John Swifka (J).

Foreign: Jacques Bia (F M) Afr… Cecil George Dixon (A), South Afr… Government of India, War Departm… (Depart'l) Rep: Lt.-Gen. C. A. Bird, Ind… Frantisek Leopold Mautner (J), Engla… P. Thijssen (F M), Netherlands West Indi… Ernest F. Upshall (F M), England.

APPLICATIONS Received

The applications for membership received between May 10, 1943, and June 10, 1943, are listed below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

Baltimore Section: Sidney H. Fedan, Sidney Helfman, Charles O. Maguire, A. R. Ruth, Edwin Herman White.

Buffalo Section: Verne P. Donner, Douglass Fennell Evans, Clifford Cook Furnas, Burdette S. Wright.

Canadian Section: Alfred M. Bell, Frank Martin Booth, Joseph James Brown, Paul James Henderson, H. W. Jones, Gordon Blake Lang, H. S. Shannon, William George Walsh, Q. C. Woods.

Chicago Section: H. Wade Barth, Clifford E. Bowdish, L. L. Colbert, William R. Gerber, Loren B. Grimsley, William J. Harris, Frederick Osann, Jr., Samuel L. Sola, T. W. Tinkham, Otto E. Wagenknecht.

Cleveland Section: John W. Bond, John M. Davies, Dean Driscoll, Carroll Sherman Eian, Albert Hoye Godfrey, Jr., Alfred C. Gunsaulus, Ross W. Henry, Parry Keller, Dwight L. Loughborough, J. Arnold McCoy, Rollin Henry Spelman, Jr., Norman L. Wuerz.

Detroit Section: Albert Victor Apblett, George W. Beltz, George D. Bogoliubov, Alexander Carlin, F. W. Corwin, Alvin N. Cover, George I. Goodwin, Gilbert F. Hauke, W. G. Howe, Edwin B. Jackson, Edgar M. Johnson, Philip C. Johnson, Frank J. Koehl, Theodore A. Kreuser, Wallace O. Leonard, Victor C. Moore, Charles H. Ray, Forrest V. Rhodes, William W. Sanford, S. Gordon Saunders, Norman A. Schassberger, Robert E. Schieber, Charles Earl Sexauer, A. E. Shelton, John Dale Thompson, Earle A. Tomes, Carl A. Underhill, George H. Van Husen, Paul R. Vogt, Lloyd J. Wolf.

Indiana Section: Orville Charles Cromer, Kerkling & Co., Inc., William W. Loman, Charles Willard Van Overbeke.

Kansas City Section: James Winton Amis, Jack Frye, E. J. Ziegler.

Metropolitan Section: Robert W. Beyland, Walter W. Burrows, Frederick J. Demetrius, Harrison William Flickinger, Vincent James Giangrande, James J. Heatley, A. N. Kemp, Fred L. Kolb, Jr., Barney Lifshey, Albert S. Ogden, Martin P. Schira, Jr., Edward D. Shores, Rainer G. Siener, Andrew George Staller, George Stern, John Paul Thomas, Lawrence F. Wilkens, Felix Edgar Wormser, Alexander Zeitlin.

Mid-Continent Section: Lester Lee Helm, Roy DeLosse Ward.

Milwaukee Section: Allen Bartlett, Arthur G. Bitzer, Jr., Lewis H. Collison, Frank Anton Grabarczyk, Roy W. Johans… David T. Marks.

Mohawk-Hudson Group: M. J. Severin…

New England Section: Fred L. Bru…ger.

Northern California Section: Arthur Darwin Duchow, Frank R. Hin…

Northwest Section: Orville P. Marti… Ray E. Robinson.

Oregon Section: Walter G. Auer, … George H. Wilson.

Philadelphia Section: Charles C. Cup… Linn Edsall, James E. Higgins, Merrill A… Lott, Murrell Dobbins Vocational Scho… Harold J. Schramm, Leslie B. Schramm… George John Stradtner, Richard H. William…

St. Louis Section: Henry A. English… Charles Warren Neff.

Southern California Section: J. C… Armeling, Harry M. Baker, Sr., J. R. Bixby… Jorge Cecil Chesworth, Thomas O. Dahl… strand, Lester E. Everett, John Cliffor… Garrett, Alfred Mynderse Goldman, Ezr… Hollister, Disbrow Pettit Johnson, Louis P… Merandi, R. T. Nelson, Homer H. Rhoads… Owen Walker, Jr., J. P. Seamons, Frank S… Wyle.

Southern New England Section: William Maxwell Scranton, James R. Thomson.

Southern Ohio Section: J. R. Bengoechea, Alan Howard Blair, Charles H. Flasch.

Syracuse Section: Lewis E. Pierson, Jr., Youston Sekella, Edwin B. Watson.

Texas Section: Fred Boatright, James E. Bourland, John C. Bowman, Richard Ostlund, Douglas R. Stocks.

Twin City Group: Lynn G. Barnes, William Henry Furst, Richard L. Nelson, Carl R. Reller, Frank E. Torrance.

Washington Section: Lt. (j.g.) James Hough Henry, Charles Ray, Charles W. Wood.

Wichita Section: Charles M. Jamieson, Robert B. Short, William W. Thomson.

Outside of Section Territory: Harold W. Anderson, Edwin R. Clarke, Leonard L. Conopa, Lt. Jack I. DuBoff, Louis John Fleischman, Walter G. Fortune, J. Harold Foster, Perce E. Garlent, Everard L. Hemingway, John Arthur King, W. E. Martin, Joseph F. Meade.

Foreign: Gerald Stafford Owen (England), Cyril Harding Sprake (England).

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